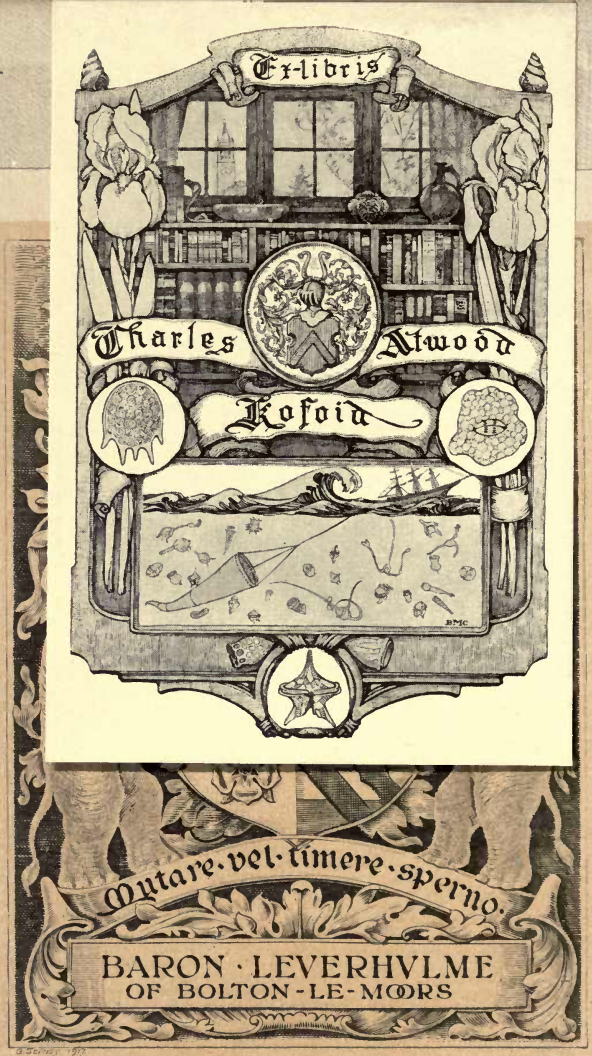
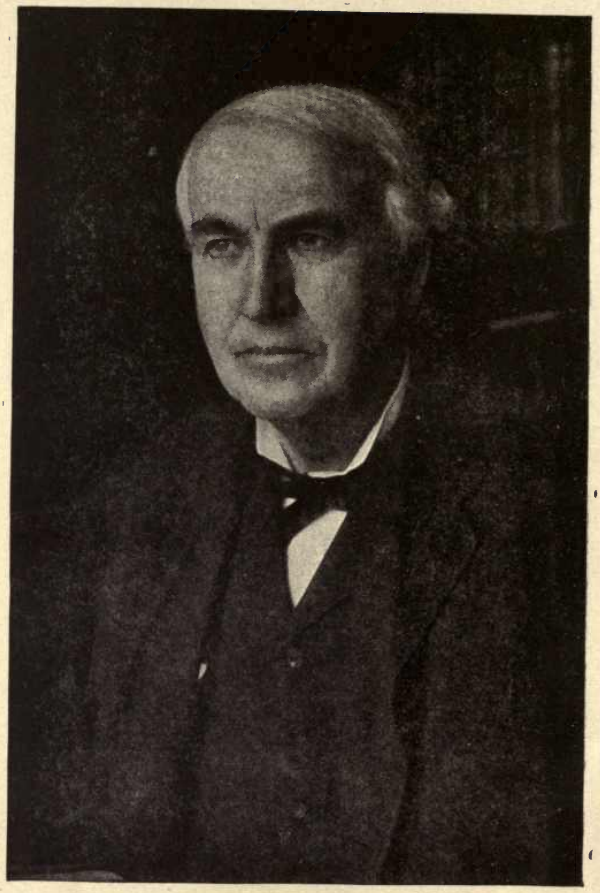
# THOMAS A. EDISON


Ex-libris
Charles Atwood
Kofoid
BMC
Mutare · vel · timere · sperno.
BARON · LEVERHVLME
OF BOLTON-LE-MOORS

THE LIBRARY
OF
THE UNIVERSITY
OF CALIFORNIA

PRESENTED BY
PROF. CHARLES A. KOFOID AND
MRS. PRUDENCE W. KOFOID

# THOMAS A. EDISON



THOMAS A. EDISON

*Fr.*

# THOMAS A. EDISON

## THE LIFE-STORY OF A GREAT AMERICAN

*WITH EIGHT ILLUSTRATIONS*

LONDON
GEORGE G. HARRAP & COMPANY
2 & 3 PORTSMOUTH STREET KINGSWAY W.C.
MCMXVII

THE RIVERSIDE PRESS LIMITED, EDINBURGH
GREAT BRITAIN

TK140
E3T5

# CONTENTS

CHAPTER PAGE

I. The American Way—The Childhood of a 'Self-made Man'—How a Newspaper is founded without Money and without Collaborators 9

II. Apprenticed to Magic—How Electricity is transformed into Money—Science and Business . . 43

III. Edison the Napoleon of Modern Times—The Fairyland of Menlo Park—Edison at Work and Edison at Play . . . . 81

IV. Distance is abolished — Edison starts upon the Conquest of the Old World of Europe . . 104

V. Recording the Voice—Is it a Ventriloquist?—Glory and Harmony imprisoned in a Cylinder . . 119

VI. Let there be Light! And there was Light!—And this Light emanated from America . . 148



M368123

CHAPTER PAGE

VII. Recording the Gesture—In Full Fairyland—A few other Marvels, Small and Great . . . 170

VIII Mr Edison does not receive—But he will receive us—Llewelyn Park at Orange, New Jersey—The Recipe for Genius and Success . 184

# ILLUSTRATIONS

PAGE

THOMAS A. EDISON . . . *Frontispiece*

EDISON FOUND HIMSELF ON THE PLATFORM, IN THE MIDST OF HIS BROKEN INSTRUMENTS . 32

"WHAT WOULD YOU SAY TO FORTY THOUSAND DOLLARS?" . . . . 78

THE FIRST PHONOGRAPH . . . 126

EDISON AND THE PHONOGRAPH . . 144

THERE CAME A BREATH OF WIND, AND THERE THE FILAMENT WAS, BROKEN LIKE ITS PREDECESSOR . . . . 154

EDISON THE CHEMIST . . . 182

LLEWELYN PARK . . . . 200

# THOMAS A. EDISON

## CHAPTER I

THE AMERICAN WAY—THE CHILDHOOD OF A 'SELF-MADE MAN'—HOW A NEWSPAPER IS FOUNDED WITHOUT MONEY AND WITHOUT COLLABORATORS

IF there is any one far-echoing name inscribed in the full light of day above the portals of the Temple of Fame in this first half of the twentieth century, so fertile in human progress, it is beyond question that of Edison. He is not only one of the master minds of his time, but the most extraordinary type of the modern inventor. This he is to the full extent of his creative power, devoted wholly to the needs of real and practical life. No one before him and no one since has equalled him in placing the unknown forces of Nature at the service of society, subduing them to our use, and at the same time obtaining from them a maximum of efficacy.

It is in this sense that Thomas Alva Edison, this essentially American genius, utilitarian by definition, appears as a sort of Poet Extraordinary of the universe, a marvellous magician of these later times. His fertile and prodigious ingenuity, by extending the domain of our senses, has opened up vast and unlimited fields to our activity.

We are witnessing the beneficent and at the same time formidable reign of mechanism and industry, which are the characteristic elements of civilization. It is the reign of speed, it is the reign of electricity, it is the reign of Edison.

What is the secret of these famous discoveries by Edison ?

Edison himself believes in effort, in work, in fearless and persistent thinking. Chance, no doubt, plays its part in the success of intellectual research, just as in all other enterprises. But it is made effective only by prolonged reflection and unflagging toil. It is thanks to these qualities alone that inspiration bears its fruit. Without a constant expenditure of physical labour, the most penetrating glance, the keenest insight run

the risk of remaining sterile. Think of the care which must be lavished upon a beautiful plant in order to bring it to its full flowering! And is it not the same with human genius, in spite of lucky chances and the gifts of Nature?

In this respect the life of Thomas Alva Edison serves as an admirable lesson.

We have said that Edison is the type of American genius; and, as a matter of fact, he appears at first sight as the finished and exemplary type of the 'self-made man,' who has succeeded in triumphing over all the difficulties of existence, thanks to the inexhaustible resources of his own energy. We are constantly hearing of the importance of putting one's heart into one's work; it is the favourite advice given to the young who are eagerly preparing to enter the struggle for life. But formulas are employed far too often without trouble being taken to define them. In this respect there is no better example nor a more significant one than that of Edison. His dazzling ascent toward fortune, toward universal and immortal fame, has the value, equally in France and the United States, of a lesson of the very

first order, we might even say a unique lesson.

We shall see presently in what sort of an environment and as a consequence of what events Edison unhesitatingly sought and found himself. But, without attributing an excessive influence to heredity in shaping the destinies of great men, it is only fair that we should ask in the first place what were the antecedents of Thomas Alva Edison, and whether, in revealing himself to us with all the marks of a striking originality, he has not been simply obeying certain family traditions of high intelligence and audacious initiative.

On his father's side he comes of Dutch stock. His ancestors were mill-owners in the Netherlands. Certain members of the Edison family, in the company of other emigrants, landed in North America about the year 1737. Among them was John Edison, the great-grandfather of the inventor, who before long achieved distinction and became a banker of repute in New York. But when war broke out between England and the Colonies he openly took sides with the mother country and declared himself an implacable foe to separation. In spite of his advanced

age, he was forced to seek safety, with his entire family, in Nova Scotia.

The loyalists were entitled to compensation. Accordingly, in the year 1811, John Edison received, as the price of his fidelity, six hundred acres of land for himself, four hundred for his son Samuel, and two hundred for each of his grandchildren.

All of the Edisons seem to have enjoyed excellent health and to have lived to a ripe old age. John and Samuel were both upward of a hundred years old at the time of their death. A son of the latter, the second Samuel Edison, lived in Bayfield, on the shore of Lake Erie. It is said that he was six feet in height, that he had the suppleness of an Indian and the strength of an athlete, and that there was no one who could outrun him. These advantages proved to be distinctly useful during one memorable episode in his career. This Samuel Edison was very far from sharing the sentiments of his grandfather in regard to England. The flame of rebellion leaped up among the Canadians, fanned by the sustaining sympathy of the United States. Samuel Edison, who had been one of the most important leaders of the

revolt, was forced to flee, and, in order to save his life, accomplished a journey of almost a hundred and eighty miles without food or sleep. He did not feel that he was safe until he had reached United States territory, after crossing the St Clair River.

We must not forget that this energetic man, capable of such prodigious efforts, was the father of Thomas Edison.

After a short stay in Detroit he removed to Milan, a small village in Ohio, where he opened up a business in grain and lumber, which was greatly stimulated by the extensive traffic of the canal. On the 16th of August, 1828, he married Miss Nancy Elliot, who, although a Canadian by birth, belonged to a family that originally came from Scotland. Highly educated, with refined manners and unusual strength of character, she appears to have been an exceptional woman, as well as a teacher of rare ability. As a matter of fact, she had held a position in a high school. Possessing some of the rarest qualities of heart and mind, she was destined to exercise a peculiarly beneficent influence over the awakening of an exceptional intellect.

It was in this little Ohio village of Milan that Thomas Alva Edison was born, on the 11th of February, 1847. It is pleasant to imagine his free, happy childhood, in and out among the big grain elevators or along the lively shores of the little lake, near the banks of the canal. His parents, who at that time were in easy circumstances, thanks to a prosperous business, and were able to look forward to a promising future, watched over their son with the tenderest solicitude.

We may feel doubtful as to the picturesque anecdotes which are so freely told regarding the precociousness of children who later become celebrated. Here is a point where legend blends so easily with history. We do not see any necessity for adding a few little useless inventions to the great inventions made by Edison himself. Nevertheless, it is easy to understand why his admirers love to surround with mystery even the slightest acts and gestures of this remarkable wizard, the inventor of the phonograph. As a matter of fact, it is a waste of time to try to add anything to the simple eloquence of the bare facts of his life.

We should be equally careful not to

attribute an exaggerated importance to certain pleasing childish traits, on the basis of which the attempt is made to explain the future man. Nevertheless, it will do no harm to make a passing mention of the following amusing incident, that tends to show the earliest manifestations of an inquiring mind, already accompanied by a practical determination to improve upon Nature by utilizing her own methods. The story runs that little Edison, at the age of five, was astonished to see a duck engaged in the long and patient process of hatching her eggs. Picture the surprise of this small boy when he subsequently witnessed the successful hatching of the entire brood! How did it happen? And why? The child became deeply preoccupied over this mystery. He asked questions and learned that the bird obtained this happy result through the natural warmth of her body. Shortly afterward the boy was sought for and could not be found. But at last he was discovered in a barn, sitting upon a number of eggs, waiting confidently for them to hatch.

What countless experiments Edison has attempted since that time! Once again we

must remind ourselves that the singular activity of this great scientist extends throughout the entire domain of Nature, from whom he is striving to wrest her most treasured secrets. As a small boy he astonished not only his father but all the inhabitants of the town as well by his questions, his tireless and insatiable curiosity. He loved to slip away from home and wander at will through the shipyards, exploring the machinery and frequently incurring some rather grave dangers. On one occasion he lost part of a finger through the indiscreet use of an axe; and more than once he barely escaped being crushed while examining too closely the workings of certain apparatus that had aroused his wonder.

At another time he set fire to a barn, and it was only with the greatest difficulty that he himself was rescued from the flames. As an exemplary punishment he was publicly whipped in the village square, receiving a goodly number of strokes. But his hardihood was in no wise lessened, for all that. The reckless lad was as fearless of water as he was of fire. He used to swim with other boys of his own age, and one day

one of his companions disappeared beneath the surface. On several occasions Edison himself narrowly escaped drowning. He was blessed with splendid health; and, far from shrinking from adventures, he went in search of them. During one of his cross-country escapades he was attacked and badly injured by a ram.

It is interesting to note in passing that this brave little dare-devil already foreshadows the future man of action, who never spares himself, just as the little reasoner who wishes to inform himself as to the *how* and *why* of everything foreshadows the future man of thought.

These two things are never separated in Edison, whose physical and mental endurance have always been equally remarkable. Must he not necessarily have been somewhat foolhardy before the audacity of his first impulse was tempered by more judicious second thoughts? His ability to dismiss all thought of fear, when he undertakes to explore the possibilities of any problem that has engaged his serious attention, forms an element of fundamental importance in his success. This is a point that cannot be too strongly emphasized.

It was not long before Edison's parents saw the downfall of their bright hopes. The construction of a railway along the shore of Lake Erie dealt a fatal blow to Samuel Edison's business, in spite of all that he could do to save it. The situation had already become precarious, when a financial crisis rendered it still more alarming. But Samuel Edison was not of the kind that allow themselves to be beaten down by the adverse strokes of Fate. He removed to Michigan, and installed himself and his family in Port Huron, on the boundary line between Canada and the United States.

Little Thomas was at this time seven years old and had been attending school for only two months. Partly as a matter of economy, partly also because she wished to direct personally the development of an intellect that was so near and dear to her, his mother decided that she herself would give him his grounding in the first principles of the sciences, striving always to keep the child's eager curiosity on the alert and to keep a watchful eye over these first efforts of the imagination made in conjunction with study and reflection.

It is pleasant to conjure up the pretty

picture, in its setting of that broad and sunny farm in Michigan: Edison's mother transforming herself into his one and only preceptor, a school teacher as far-seeing as she was sympathetic. Young Thomas Edison could not have been slow to profit by a system of instruction which recognized the full importance of the pupil's initiative, and to show the full extent of his courage and originality. In spite of his precocious astonishment in the presence of the phenomena of Nature and his swiftly kindled love of experimenting, the child showed the keenest desire to acquire a broad grounding in the theoretical branches. For that matter, Edison has never at any time been disdainful of the mental culture that is derived from books. Even now, all the sources of documentary knowledge are regarded by him as profitable. And how is it possible to conceive of the present and the future if the past remains unknown to us?

At the age of ten this son of a vigorous race, in his keen desire to know and to do, had read Gibbon and Montesquieu, d'Aubigné's *History of the Reformation*, Sear's *History of the World*, *The Penny Encyclopædia*, and Ure's *Dictionary of Sciences*. He

devoured works of all kinds, and could remember the precise page and position of passages which had impressed him as especially curious. It is also related that he had been introduced very early, no doubt too early, to Newton's *Principia*, and that, being discouraged by the obscure reasoning from axiom to axiom, he was destined to preserve a certain degree of aversion for everything pertaining to mathematics.

This determination to enrich his mind by eager and abundant reading, which was an important trait to note in connexion with Edison's early youth, has remained, no doubt, characteristic of the man. But it is necessary to see him at work, actively engaged in his tasks, in the midst of life which was forced to smile upon him because he did not fear to confront it with the marvellous resources of a most tenacious energy, united to a faculty which from the start was amazing and soon became miraculous, the faculty of creating, through means that were exactly adapted to present needs, or to the exigencies of real life.

It is in this aspect that Thomas Edison has revealed himself; and he has done it in a manner that may be defined at one and the

same time as extremely American and extremely, even sensationally, individual.

At Port Huron the Edisons continued to live in a very modest fashion. But the reports that their financial condition was disastrous are quite unfounded.

At the age of twelve, as a result of his own initiative, the lad succeeded in obtaining the profitable privilege of 'train-boy' on the Grand Trunk Railroad, the great through line running from Quebec to Montreal, and, by way of Toronto and Detroit, all the way to Chicago. His duties consisted in going from car to car, between the two stations of Detroit and Port Huron, and selling newspapers, fruit, and various other articles to the passengers, whom he delighted by his quick wit and engaging manners. He put so much energy and ability into this small business venture that it is said that his profits rose to something over forty dollars a month, to the great delight of his family. He passed the hours between trains in the Detroit public library, or busied himself with sorting out his papers in the printing office of *The Detroit Free Press.* Meanwhile the energetic lad began, little by little, to extend his business

operations in various ingenious directions, notably, as the celebrated inventor himself revealed later on—and for these far-off years it is well to be mistrustful of hearsay and accept only the evidence of the man himself—by transporting two large baskets of vegetables from the Detroit markets to Port Huron, where they sold to excellent advantage. Along the line he bought butter from the farmers, and blackberries, which he sold at a low price to wives of engineers and to the employees on the train. When a special emigrant train of from seven to ten cars was put on he hired an assistant to sell bread, sweets, and tobacco.

In these ways his profits began to multiply, and, thanks to his far-sighted business activity, they increased to the point of between eight and ten dollars a day. Out of this he regularly sent one dollar to his mother; but the greater part of his savings was devoted to the purchase of technical works, and more especially to his experiments in chemistry. For this purpose he actually went so far as to install a sort of laboratory, with flasks and test tubes, in a car that was intended for baggage.

This determined young fellow, whom every-

body liked for his ready wit and self-assurance —this veritable young scamp, as he was freely called—made sport of difficulties. Before long his natural gifts for taking the initiative and for making inventions were revealed in a still more conspicuous manner. The civil war had broken out. Passengers were eager for news. Young Edison straightway recognized the advantage that he might derive from these circumstances, which gave special importance to the sale of his papers. In Detroit he made the acquaintance of the type-setters on *The Detroit Free Press.* By running his eye over a proof sheet of the paper he could inform himself of anything that it contained of special interest. It was in this way that on a certain day in April 1862 he was one of the first to read the absolutely sensational news relating to the battle of Shiloh, which lasted for two days, in which General Grant won a victory over the Southern forces, General Johnston was killed, and the dead and wounded were estimated at 25,000. But after the first reports the issue of the battle remained uncertain and there were rumours of from fifty to sixty thousand victims. It was a matter

of vital interest to the public. Thomas Alva —'Al,' as he was familiarly known on the Grand Trunk Railroad—instantly saw an opportunity for putting through a neat little business deal. As he happened to know the telegraph operator at the Detroit railway station, he lost no time in making the following proposition to him over the wire: "Telegraph every stationmaster the latest news of the battle and number killed, and ask them to write the same on the blackboard used for announcing the time of arrival and departure of trains; in return, I will give you a free subscription to the newspaper, as well as to *Harper's Weekly* and *Harper's Monthly*, for six months." The telegraph operator accepted the offer. Thanks to this unusual publicity, the sale promised to be an exceptional one. But how was young Edison to rise to the heights of the situation? He had not money enough to buy more than the customary limited number of copies of *The Detroit Free Press*. What could be done? How many boys are there who would not have given up in the face of such an obstacle? But this venturesome youth did not hesitate to employ big methods.

He insisted upon seeing the editor upon a matter of important business. At all events, it was a matter of importance to him. He was shown into an office where two men were talking. One of these men, the younger one, after hearing Edison's plan of having the latest bulletin telegraphed ahead, and his request for credit for a thousand copies, in place of three hundred, curtly refused. But the older man, Mr Wilbur F. Storey, who subsequently founded *The Chicago Times*, intervened in favour of this lad with the decided manner. With the aid of another boy, Edison transported the thousand copies to the train, and, as it started out of the station, set himself to the task of folding them.

At this point let us allow Edison to relate in his own spirited way this characteristic adventure: "The first station, called Utica, was a small one where I generally sold two papers. I saw a crowd ahead on the platform, and thought it some excursion, but the moment I landed there was a rush for me; then I realized that the telegraph was a great invention. I sold thirty-five papers there. The next station was Mount Clemens, now a watering-place, but then a town of about one

thousand. I usually sold six to eight papers there. I decided that, if I found a corresponding crowd there, the only thing to do to correct my lack of judgment in not getting more papers was to raise the price from five cents to ten. The crowd was there, and I raised the price. At the various towns there were corresponding crowds. It had been my practice at Port Huron to jump from the train at a point about one-fourth of a mile from the station, where the train generally slackened speed. I had drawn several loads of sand to this point to jump on, and had become quite expert. The little Dutch boy with the horse met me at this point. When the wagon approached the outskirts of the town I was met by a large crowd. I then yelled. 'Twenty-five cents apiece, gentlemen! I haven't enough to go round!' I sold all out, and made what to me then was an immense sum of money."[1]

In spite, however, of all the pleasing results that he achieved, this business of selling newspapers failed to satisfy young Edison. He determined to have a paper of his own, of which he should be the editor. And he did

[1] From Dyer and Martin's *Life of Edison.*

it. He bought a fount of type and a little press which was intended for printing bill-heads and catalogues. And there he was, installed as editor, type-setter, and reporter, all of which in no way interfered with his continuing his business of selling newspapers. It was in his luggage-van laboratory, while making the daily run, that he compiled and set up *The Weekly Herald*, single copies of which were sold for three cents, while the monthly subscription was to be had for eight. Let us, out of curiosity, cast a glance over a copy of this *Weekly Herald*, which must be remembered by the inventor as one of the earliest and most picturesque products of his creative spirit. The leading article, under the head-line 'Local News,' is nothing more nor less than a respectful recommendation calling the attention of the company's officials to the merits of a certain engineer. Every six months a prize was given to the one who had been most economical in the use of wood and oil during his daily run, and a certain E. L. Northrop was recommended to the consideration of the company as one of the most deserving.

It is easy to see that this young 'Al,' this

irrepressible young imp who amused everybody by the variety of his ideas and the rapidity of his movements, had a true journalist's instinct for the art of profitable advertisement. Thanks to this instinct, he secured for himself much valuable co-operation. He never was above inserting a friendly paragraph, in tribute to the humblest of the railway's employees, and he secured their goodwill in return.

Another article of thirty-six lines is devoted to the misadventure of a certain Mr Watkins, who claimed damages to a large amount from the company, on the ground that it had lost his valise. Now, the said valise was finally discovered in the possession of the claimant himself. His friends were endeavouring to hush the matter up, but against this the journalist protested with lively indignation.

On the second page of *The Weekly Herald* we find information relative to the schedule of trains, with the hours of arrival and departure, commendatory notes such as this: "S. A. Frink. Mr Frink is one of the most prudent drivers in the United States," and news items such as the following: "Cassius

M. Clay will enter the army on his return home," "The thousandth birthday of the Empire of Russia will be celebrated at Novgorod in August." Then follow announcements of lost articles and a list of the current market prices in Baltimore—for butter, eggs, lard, beans, potatoes, chickens, geese, turkeys, and wild ducks.

Last of all, advertisements occupy, quite properly, considerable space. Here are some specimens :

"Railroad Exchange. At Baltimore Station. The above-named hotel is now open for the reception of travellers. The bar will be supplied with the best of liquors, and every effort will be made to promote the comfort of guests. S. Davis, Proprietor."

"Ridgeway Refreshment Rooms. I would inform my friends that I have opened a refreshment room for the accommodation of the travelling public. R. Allen, Proprietor."

"To the Railroad Men. Railroad men, send in your orders for butter, eggs, lard, cheese, turkeys, chickens, and geese. W. C. Hulets, New Baltimore Station."

This singular journal, unique of its kind, published and sold upon a moving train, to

the extent of several hundred copies, brought in a monthly profit of between £6 and £8. It was this *Weekly Herald*, published by Edison, that made his name known to the readers of *The Times*, the English engineer Stephenson, while inspecting the Grand Trunk system, being much struck by the ingenuity of this enterprise by a young lad of barely fifteen years.

Meanwhile, a slight incident was destined to change the whole course of his existence. At the same time that he developed an absorbing interest in fiction and exhibited manifestations of poetic genius to such an extent that he was nicknamed 'Victor Hugo Edison,' he continued, in his compartment in the luggage-van, his experiments in physics and chemistry, by the aid of more or less perfected apparatus.

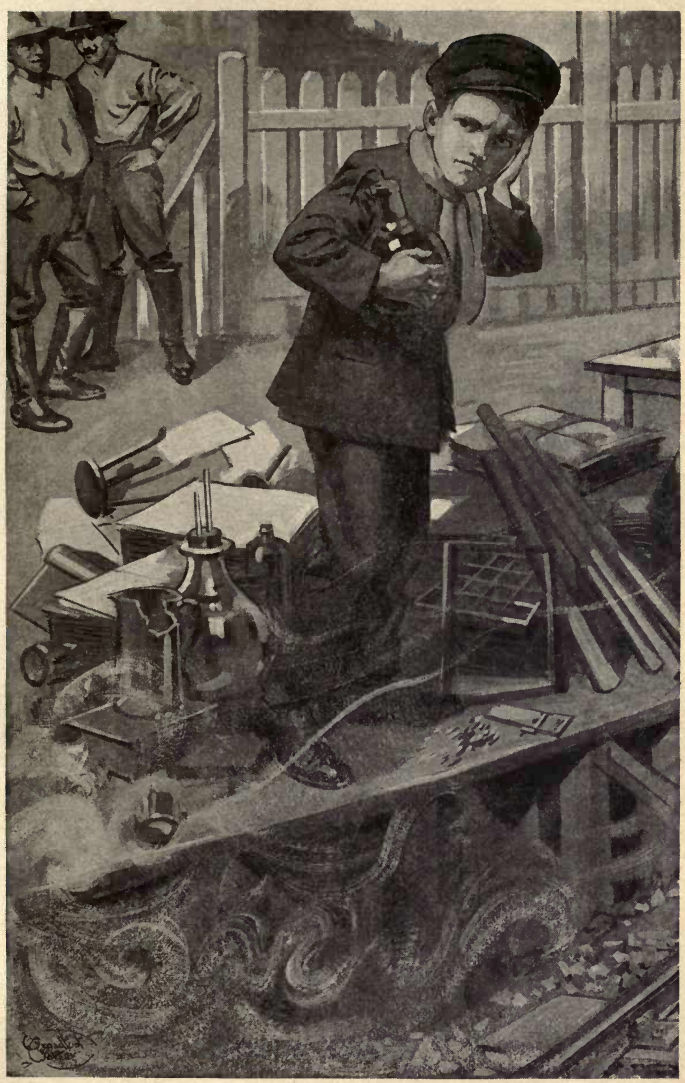
One fine day, or, more accurately speaking, one very evil day, the train, while running at high speed, gave a sudden and violent lurch. A piece of phosphorus fell to the floor and burst into flame. The car caught fire. The young experimenter, with the aid of the conductor, succeeded in putting out the blaze. This conductor, a brutal and vindictive

individual, did not hesitate, at the very next station, to fling out upon the platform the contents of poor Edison's laboratory and his entire printing outfit besides.

When the train started again Edison found himself on the platform, in the midst of his broken instruments and ruined hopes! Messrs F. L. Dyer and T. C. Martin, the authors of the authoritative *Life of Edison*, add that the angry conductor had, in addition, boxed the boy's ears so vigorously that his ill-considered violence was the cause of the famous inventor's permanent deafness.

This incident amounted at the time to a veritable disaster. But, like his father, young Edison was incapable of being discouraged, or of yielding to circumstances. Accordingly, he removed his laboratory to his parents' home, promising that he would observe the greatest possible prudence.

Meanwhile he did not abandon journalism. On the contrary, he joined forces with the son of a printer, and between them they founded *The Paul Pry*, in which they proceeded to lampoon with a good deal of freedom the doings and peculiarities of their fellow-citizens. One of the latter, smarting



"EDISON FOUND HIMSELF ON THE PLATFORM, IN THE MIDST OF HIS BROKEN INSTRUMENTS"

from the sting of their satire, laid violent hands upon the impertinent editor-in-chief and flung him into the St Clair River.

This incident caused little concern to the youthful adventurer, for he knew how to swim. But he felt that his dominant tastes and aptitudes were drawing him in another direction. Accordingly, he renounced journalism, notwithstanding that it was a profession which appealed to his adventurous spirit and might have procured him some new and pleasurable experiences. Who knows whether Edison, in the full flowering of his glory and his fortune, does not look back longingly to his profession of long ago, even while he dreams of replacing paper, upon which thought is materialized, by some better and more durable substance ?

But at that period young ' Al ' was already experiencing a passionate curiosity regarding the extraordinary phenomena of electricity. He asked himself how it was that telegraphic messages could be transmitted, and more especially what were the fundamental principles of telegraphy. Since his mother had allowed him to install his laboratory in

the cellar, he decided to run a wire from this somewhat primitive workshop to the home of one of his friends, John Ward by name, in the immediate neighbourhood. The two collaborators set to work. They constructed their line out of ordinary iron wire. Bottles served as insulators. And they used a piece of cable, fished out of the river. All this was very good, so far as it went. But how were they to produce electricity? That was the question!

Edison set himself energetically to work, stroking the back of a cat in order to produce a current. The story is an amusing one, but it has its significance. However, by uniting their resources, the two boys were able to purchase the needed supplies, and before long had completed their apparatus.

Minds that are too narrowly precise and men of limited attainment, as has been very justly observed, are seldom apt to leave the beaten track; they are afraid of ridicule. And they are readily induced to consider tendencies of this sort as clear proofs of weak-mindedness, instead of recognizing them as the first manifestations of a forceful nature. Consequently, people who are too much

afraid of appearing foolish in the eyes of the multitude of frivolous critics with whom we are always surrounded will never reap any profit themselves and will never profit any one else through their discoveries—and for the very good reason that they are totally incapable of doing so, even by accident.

As a matter of fact, all great discoverers worthy of the name have at one time or another been regarded as dreamers, not to say insane. It has been only too often their sad fate to have ridicule heaped upon them; for, in order to create an unknown order of ideas or of things, is it not necessary, in many cases, to act in defiance of common sense?

Mr Johnson, who was for a long time a collaborator of Edison, has made a very sensible comment in this connexion: "He strokes the back of his cat. Well, that is an act that is characteristic of his temperament. Even to-day he still continues to undertake experiments and to multiply them with infinite care and marvellous patience, notwithstanding that his own reasoning has not only not encouraged him, but even tended to prove to him their utter futility. This is

precisely why he now stands at the head of those who succeed in making observations and inventions of which the majority of mankind are incapable." When we study in detail the history of Edison's inventions, we recognize how much truth and profound insight is contained in such an appreciation as the foregoing.

Edison's inventive spirit revealed itself in more ways than one, in connexion with his early attempts at telegraphy. His father had given him permission to sit up at night until half-past eleven, but no later. This by no means suited his purpose, because the business of selling papers, which he still continued, took up a great deal of his time. It was his habit, when he came home in the evening, to turn over to his father such papers as had not been sold. The latter would read them before going to bed. But one evening the wily lad pretended that he had left the papers at his friend's house by mistake. But that did not matter, because his telegraph line could immediately put his father in possession of all the latest news! It was in such ways as this that this young Edison made his earliest inventions serve his

own personal needs. For, with the father's willing co-operation, the two chums continued to carry on a telegraphic conversation up to one o'clock in the morning.

Before long, however, the line was wrecked by a cow which had broken loose and conceived the unfortunate idea of taking a short cut through the orchard. Meanwhile our amateur telegraphist was dreaming of supplementing, by practical and serious study, his few vague notions of electricity, which he had nevertheless already used to advantage. He found his opportunity, as the sequel to an incident which did him honour, and which furthermore gave his life a new and definite bent that was soon destined to become permanent.

The train which Edison was in the habit of taking for Port Huron, where he bought his papers and other supplies, used to make quite a long stop at Mount Clemens. There he had made friends with the station-master, an excellent sort of man by the name of Mackenzie. One morning, in the month of August 1862, he discovered Mackenzie's son, Jimmy, a child of two and a half, playing with pebbles and sand, in the middle of the

railway track, oblivious of the fact that a moving car, uncoupled from the rest of the train, was only a few yards away. Edison barely had time to drop his bundle of papers, fling himself upon Jimmy, and snatch him away from certain death. The two rolled over and over on the ground, escaping with only a few scratches.

Mackenzie was eager to show his gratitude for the brave deed. But he was poor and burdened with a large family, so that a present worthy of such an act of devotion was out of the question. Accordingly he offered to teach Edison not only how to operate a telegraph key, but whatever else he himself knew of electricity. The boy joyfully accepted the offer, and made arrangements with one of his comrades so that he could spend the longest possible time at Mount Clemens. It is told that within ten days he had constructed a complete miniature set of telegraphic instruments which worked to perfection, to the great amazement of the station-master.

Edison gave himself up to these new studies with extraordinary ardour. He sometimes spent as much as ten hours at a

stretch manipulating the instruments, seeking to perfect himself or to discover some new way of utilizing their various different parts. From this period we may date Edison's development of his truly American gift of perceiving, in clear and rapid fashion, the best method of utilizing circumstances in order to obtain practical results. Since the town of Port Huron was about a mile from the station, he constructed a short telegraph line, to establish connexion between the two. An office was installed in a chemist's shop. In this little venture Edison took Mackenzie's brother-in-law, Paul Benner, into partnership. The price of a message was fixed at twelve and a half cents. The toy apparatus that Edison had himself constructed served the purposes of this line. The line itself was of common iron wire, fastened to posts with ordinary two-inch nails. The wire worked all right in dry weather, but could not be used when it rained. During the first month three dispatches were sent. After that the enterprise was abandoned.

By this time young Edison had begun to be the talk of the neighbourhood, because of his precocious talents and his surprising

initiative, sometimes more fertile than at others, but always interesting because of the unexpectedness of his ideas and even his smallest efforts. It happened that the telegraph operator at Port Huron, wishing to resign in order to join the army, recommended Edison to his brother-in-law, named Walker, as his successor. It should be remembered that the telegraph lines were not controlled by the Government, but by private companies. The office was situated in the shop of a jeweller, who also sold newspapers and magazines. The ingenious and persevering boy spent his entire days and nights in the office, and before long had made himself useful through various innovations, notably the completion of the line from Port Huron to Sarnia.

Nevertheless Edison did not at this time flatter himself that he was either a model operator or a model employee. He turned deliberately, at the beck and call of a passing fancy, from one line of research to another; at one time we find him handling the watchmaker's outfit; at another, he has reverted to his chemical experiments, or is deep in the pages of some new scientific work. It is

necessary to dwell upon the very personal character of these miscellaneous pursuits, this strange capacity for giving a maximum of attention successively to most widely different subjects. Such was Edison at this early epoch, and such he still impresses one as being at the present day.

Accordingly it is easy to understand that, while he had in him great creative genius, his originality and intellectual independence did not predispose him to become a model servant. He did not stay long at Port Huron. His ambition was to become a telegraph operator on the Grand Trunk Railroad. He obtained the position of night operator at Stratford, in Canada, a station not far distant from Bayfield, where the Edison family still had friends. His salary was twenty-five dollars a month.

This brings us to the year 1863. Young Thomas Alva Edison was at that time sixteen years old. He had already given most remarkable proofs of his energy, and of a knowledge which his peculiar education had adapted in an astonishing degree to the needs of the moment. Also, he had already acquired a rather extensive experience.

Henceforth he is launched upon the full tide of life. He is proceeding to multiply his efforts. He is definitely upon the road to fame and fortune. From Stratford to Menlo Park and to his laboratory at Orange, from which his renown shines out with all the brilliance of electric light itself, over the New World and the Old, he has traversed a vast number of intermediate stages. But we have already seen that he was fashioned to fight victoriously against all obstacles, and to triumph little by little, thanks to the innumerable resources of courage, of perseverance, and of that indefinable something which, in the last analysis, spells genius.

## CHAPTER II

### APPRENTICED TO MAGIC—HOW ELECTRICITY IS TRANSFORMED INTO MONEY—SCIENCE AND BUSINESS

EDISON, telegraph operator at Stratford, still impresses us as the same independent young fellow, little inclined to submit to any sort of yoke, save that of his own thoughts and the strong suggestions of what may be called his creative imagination.

His stay in Stratford, which, by the way, was a brief one, is an essential date in the course of this life of incredible intensity and more than American keenness. As a matter of fact, it was at Stratford that young Edison revealed himself for the first time and very decidedly in the aspect of an inventor. The night operators worked from seven o'clock in the evening until seven in the morning. Their principal duty was to send dispatches announcing the passing of the trains. The management of the railway was naturally

anxious to know whether their dispatchers were awake and at their posts. As proof of their presence and watchfulness, they were required to telegraph every half hour on the minute the number *six* to the manager of the section.

It is easy to understand that this requirement was not at all to the taste of our young scientist, perpetually absorbed in his experiments and his dreams. That is why he gave more thought to a means of escaping from this interruption than to fulfilling his duties punctually. Accordingly he constructed a wheel the circumference of which contained certain notches, and he connected this wheel by wires with the telegraphic apparatus in such a manner that he was able to turn over his duty to the office clock and trust it to telegraph in his stead the required number *six* at even half-hour intervals.

But he was not able to congratulate himself for long upon his neat contrivance. Unfortunately for him, the manager soon discovered that even immediately after the transmission of the signal, messages addressed to Edison remained without response. An investigation followed. The trick was dis-

covered and the young operator was reprimanded, although without great severity. As a matter of fact, this contrivance which permitted him to evade a necessary regulation could be utilized in a legitimate manner under other circumstances; it was destined, at a later date, to be patented and sold to the American District Telegraph Company.

Not long after this Edison had another adventure which might have led to very serious consequences. One night he received a telegraphic order, instructing him to stop a certain train, in order to prevent a collision. As he was not expecting any such order, he let the train go by. Horrified with the thought of the danger facing the passengers in the two trains, he started on a run for a goods station near by where the trains were in the habit of stopping. As he ran he stumbled and fell into a ditch. When he picked himself out he was too late. He returned to his post in hot haste, determined at any cost to send a warning which, late as it was, could not possibly do any good. By good fortune, however, the two engine-drivers had happened to see each other in time to avert a tragedy.

Young Edison, however, was held to be none the less negligent. He was promptly suspended from his duties and summoned to appear before the general manager at Toronto. The latter censured him unsparingly and even let fall a threat of exemplary punishment: five years in prison. At this moment some visitors were introduced into the manager's office. They were strangers, and the manager received them affably. Edison seized his opportunity and disappeared. A few minutes later he had boarded a train for Sarnia, where he caught the steamer that landed him safe and sound on the shore of Michigan. Mr Edison has not preserved an altogether pleasant memory of Toronto.

After his return to Port Huron he had occasion, during the winter of 1863–64, to bring himself into prominence, under quite memorable circumstances. Enormous cakes of ice had broken the telegraph cable which connected Sarnia with Port Huron. What was to be done? Was there any way of dispensing with the cable and maintaining communication by some other method of sending dispatches? We should note that the river is more than half a mile wide.

Edison climbed into the cab of a locomotive and began to blow the whistle at longer and shorter intervals, imitating the established alphabet of the Morse Code. His message was understood and he received a reply by the same method. In this way messages were exchanged without waiting for the cable to be repaired.

This fertility of resource won for Edison a certain kind of popularity. But his restless spirit, his desire to find new solutions for the problems which haunted him, his love of experimenting, of seeking the new, the unknown, and also a sort of irresponsible delight in practical jokes, made it hardly possible for him to undertake any regular and systematic duties. Consequently we find this seventeen-year-old inventor constantly on the move, seeking one position after another as a telegraph operator. Wherever he went he impressed people with his gift of observation and his lively fertility in expedients. But, while they admired his qualities, they mistrusted his defects, and regretfully allowed him to depart, contenting themselves with more modest but safer talents.

We find him successively at Adrian, at Fort

Wayne, at Indianapolis, Cincinnati, and Memphis. And he is not yet at the end either of his troubles or of his journeyings. At all events, he is all the time continuing his self-instruction, making observations and multiplying by actual experience his practical knowledge of the instruments employed and the utilization of electric currents.

It was during his stay in Indianapolis that he invented the automatic repeater, which rendered possible the transmission of a dispatch from one line to another, without the intervention of an operator. Edison's task was to transmit dispatches to the newspapers with the utmost promptness and perfect accuracy. Now at this time he had not yet acquired that rapid handwriting for which he was subsequently famous. Consequently, in spite of his good intentions, neither he nor his colleagues were able, because of the rapidity of the transmission, to write out with sufficient swiftness the dispatches received. Hence the delays of which the newspapers complained and which wounded young Edison's self-esteem. Accordingly, he invented a method of connecting two Morse instruments. The speed with which the

telegrams were received upon the first was from forty to fifty words per minute. On the second the rate was reduced to between twenty and thirty. Thanks to this method —which was also an exceedingly interesting contrivance—Edison and his companions had all the time they needed for taking down in luxurious ease whatever dispatches were received. As may well be imagined, they had all sworn not to reveal this efficacious method of working in peace. The manager was delighted with the unusual clearness and accuracy of the dispatches handled by them, no matter how complicated the nature of the matter might be. But it happened that there were some extremely important debates in connexion with a certain new law. The telegraphic report of these debates was sent off in hot haste. Thanks to the slowing-up action of the automatic repeater, Edison and his accomplices finished their share of the task after a delay of more than two hours.

This was very far from being satisfactory to the publishers and editors of the newspapers. They hastened to enter a bitter and indignant complaint with the general manager, who promptly made an investigation. The

secret contrivance was discovered and the over-clever inventor forthwith discharged.

Edison was forced to leave Indiana. He betook himself to Cincinnati, where he found employment as an operator at a monthly salary of sixty dollars. It was here that he made the acquaintance of another operator of some twenty years of age, whose adventurous and picturesque career in America and Africa would make a veritable romance—Mr Milton F. Adams. He was one of Edison's earliest friends.

Messrs Dyer and Martin have recorded his comments and impressions regarding Edison, which it is worth while to repeat here as being a bit of authentic testimony of great interest.[1] "He was," said Mr Adams, "a young man of about eighteen years and rather uncouth in manner. He was quite thin and his nose was very prominent, giving a Napoleonic look to his face. . . . He was lonesome. I sympathised with him and we became close companions. As an operator he had no superiors and very few equals. He was all the time inventing one thing and another to relieve the monotony of the office work." And Mr

[1] *Life of Edison.*

Adams goes on to describe the tricks that Edison used to play upon his companions with the aid of electricity, and how he once arranged a battery in the cellar for the purpose of electrocuting the rats.

The chief amusements of the two friends in Cincinnati were reading, scientific experiments, and an occasional visit to the theatre. Edison had a passion for *Othello*, but this in no wise diminished the remarkable ardour that he showed in the practice of his own duties. Although he was now a day operator, he did not hesitate to take night work also, which brought him considerable extra pay. Furthermore, his salary was increased to one hundred and five dollars, and he was entrusted with the important wire that connects New York with Louisville, by way of Cincinnati. The operator in this last-named city was celebrated for his speed and accuracy. It was in this school that Edison acquired an ability of the first order. But he evidently found it impossible to remain in any one place. He was eager for new scenes; and, besides, he was anxious to secure a more and more advantageous situation and one in keeping with his qualifications as a telegraph operator.

Accordingly, he betook himself to Memphis, Tennessee, where operators were receiving a hundred and twenty-five dollars a month.

Fortune, however, was chary of her smiles, and our conquering hero found little else in Memphis than trouble and disappointment. The manager there had for some time past been seeking to perfect a repeater of his own invention. But in spite of all his efforts he could not arrive at any practical result. Edison very quickly found the required solution. But the manager, jealous of such exceptional ability, discharged a collaborator who was so little likely to add new glory to his own merits.

A dramatic, not to say melodramatic, account has been given of the young man's arrival in Louisville, half dead from cold and hunger, dressed in rags, and without a penny in his pockets. There is, no doubt, some exaggeration in all this, just as there is in the much too gloomy picture drawn of his parent's modest pecuniary situation.

It is none the less true that this journey in the company of a comrade who had himself been unkindly dealt with by Fate, Mr W. Foley, was a distressing experience: in short,

it was a good specimen of what the famous inventor calls his hard years. His health had been undermined by the countless sleepless nights devoted to toil, his purse was sadly empty as a result of many an unprofitable experience, and the two young men had been forced to make the journey on foot, in spite of bitterly inclement weather that accompanied them the greater part of the way.

Although his outward appearance scarcely spoke in his favour, Edison promptly found a position in a telegraph office in Louisville, where, curiously enough, after all his manifold wanderings, he was destined to remain for two years. During the early part of this stay in Louisville he could by no means congratulate himself upon the character and behaviour of the people with whom he was thrown in contact. None the less, he compelled esteem by his loyalty, his industry, his fidelity, and the perfect dignity of his manners.

It is related that one night, when Edison was on duty, another operator in the same office, who was usually very skilful, arrived in a state of absolute intoxication. In a

sort of alcoholic frenzy he amused himself by demolishing the stove and proceeded to turn the whole place upside down, including the entire telegraphic apparatus. Far from becoming excited, Edison calmly proceeded to repair the wires as best he could, and settled down, single-handed, to perform the double task.

The equipment of telegraph offices in those days was at best rudimentary, and the instruments were in deplorable condition. But his residence in Louisville offered all sorts of compensations. By the very nature of his duties Edison was now brought into continual relations with the members of the Press. He made the acquaintance of journalists and of poets. He loved to listen to their discussions. At the same time, while becoming an almost unequalled operator, capable of sending his forty-five words a minute, Edison continued to pursue his studies and passed his nights devouring articles in *The North American Review*. There is a significant and picturesque anecdote related in this connexion. The young man had succeeded in buying at a bargain a certain number of issues of this magazine.

Some time afterward, leaving the office at three o'clock in the morning, he happened to carry a pile of them upon his shoulder. An alert policeman thought that he had discovered a thief and ordered him to halt. Edison, who is deaf, continued tranquilly on his way. The policeman fired a shot at this suspicious character, but with such bad aim that he failed to hit him, and the two ended by making explanations and coming to an understanding.

Nevertheless, even in Louisville, where he ended by enjoying himself, Edison was all the time dreaming that he would achieve fame and happiness somewhere else. Some one had talked with him, as well as with two of his companions, of the dazzling opportunities offered to telegraph men by the Government of Brazil; while Mexico and all the countries of South America were made to appear like a veritable Eldorado. Filled with the adventurous spirit, they betook themselves to New Orleans, in order to take the steamer; but, doubtless for his own best good and that of humanity at large, Edison chanced to fall in with an aged Spaniard who had long resided in those southern countries, and who

vigorously urged him to give up such a senseless enterprise. Edison certainly had no cause to regret having abandoned the project. It was only a few years later that he learned of the death of both of his companions, victims of yellow fever in Mexico.

He very wisely hastened to return to his former post in Louisville, where he was cordially received. Meanwhile the telegraph offices had been installed in fine, roomy quarters in a new building. Here the young man was fortunate enough to win the friendship and confidence of his colleagues. It is a familiar fact that Americans are engaged, to an even greater extent than the English, in a constant fight against intemperance. We have already seen that strict sobriety was not always the rule even among the most experienced of telegraph operators. Because of his known sobriety and irreproachable conduct, Edison received from his companions the office of treasurer of a common fund, his duty being to determine the quantity of liquor to be allowed to each of them, according to their several duties and individual capacity for drinking. The treasurer's decision was to be accepted without argument

and followed to the letter. A new-comer in the office accepted these conditions without demur. Edison had the right to refuse to give out money deposited in the common fund for libations that were judged to be dangerous. This right he exercised one day against the new arrival in question. The latter rebelled, but could find no better argument to advance against an authority that was recognized by all the others than to fling himself upon this spoil-sport with the intention of 'knocking him out.' But the others intervened with so much energy that the rebellious one had to resign himself to a lengthy stay in the hospital, to recover from his many bruises.

In many respects this honourable office of treasurer was lacking in attraction. Since the others knew that he was saving money, appeals were made all too often to his purse; sometimes they even stole his books. And there was one evening when he found his bed occupied by two of his companions, who had so singularly abused his hospitality as to have retired completely dressed, without even so much as removing their shoes! This also was a result of alcohol; and accordingly

they were ejected without mercy upon the floor.

In Louisville, as elsewhere, Edison found occasion to display his peculiar aptitudes, his marvellous quality of endurance, and that extraordinary adaptation of his mind to the needs of the moment which has given to many of his actions an indefinable air of lofty and simple heroism.

It was he who received Johnson's Presidential message for the Press. He remained at his post for thirteen consecutive hours, taking down the text of that sensational telegram, from half-past three in the afternoon until the following morning at half-past four. With great ingenuity he divided it into little paragraphs of three lines each, which were distributed in rotation to the compositors. In this manner the readers of the Louisville papers were enabled to read this important communication, properly printed in its entirety, only a few minutes after the last words of it had been transmitted.

As an evidence of their appreciation of the services of this operator who had proved himself so abundantly equal to his difficult task, the editors of the Louisville papers gave

a banquet in his honour, a high compliment to his youthful reputation.

It seems probable that Edison would have continued to live quite happily in Louisville if an accident had not reopened a phase in his life that was undoubtedly rich in results, that of his love of travel, his pursuit of success across the length and breadth of the United States. At this time he still continued to devote his spare time to his experiments. But one night he had the misfortune to upset a carboy of sulphuric acid. It ran out upon the floor, went through to the manager's office below, spattered over his desk and ruined his carpet. It was a veritable disaster comparable only to that of setting fire to the baggage car of the Grand Trunk Railroad. The following morning Edison was thanked for his services, with the parting comment that what they needed was an operator and not an experimental chemist.

After this Edison returned for a short time to Cincinnati, and while there found opportunity to study the mechanism and speed of locomotives. The problem of rapid locomotion in all its forms had always haunted him—a subject to which we shall have

occasion to revert later. To this day Edison remains the man of miracles in the matter of speed.

Thanks to the kindness of the telegraph inspector of the Cincinnati and Indianapolis Railroad, he was enabled to pursue a number of interesting experiments, and to evolve the idea for a contrivance which he was destined to use much later, in his laboratory at Menlo Park, where we shall find him in the full expansion of his genius.

As a matter of fact, an invention is not merely a discovery, a distinction that Edison himself has freely discussed in personal interviews: it is a result, its value depending upon long and laborious thought and a series of more or less obscure efforts.

While at Port Huron, where he once again stayed for a time with his family, he furnished the Grand Trunk Railroad with a means of using a single cable for two currents. One of the two submarine cables which passed under the river had been destroyed, and the problem was to find a means of doing the work of both cables with the remaining one. It was the same problem as that of his duplex telegraphy, which he definitely and

practically solved a short time later. Meanwhile he profited by the occasion, and the service he had rendered, to obtain free transport to Boston.

He had written to his staunch friend, Adams, who was in Boston at the time, and had learned that there were openings there and a better chance to have his talents recognized. This prediction was fulfilled. Like a new Franklin, Edison was destined to accomplish in Boston that definite forward step which would allow him henceforth to follow his chosen path with comparative security. The road traversed by great inventors and great creators, no matter who they are, is always full of stumbling-blocks. How many small successes they must achieve before arriving at the fulfilment of their dreams!

The journey from Port Huron to Boston was a most unpleasant one. Edison suffered from both cold and hunger. The train made slow and difficult progress through a blizzard, was held up for twenty-four hours, and finally reached Montreal four days behindhand. It was a rough experience. But it was soon banished from his mind by other

experiences of a very different order which awaited the young inventor in Boston. This was in the year 1868.

Milton Adams welcomed him like a brother. He had found him a place as operator in the office of the Western Union Telegraph Company. When Edison presented himself the manager asked him :

" When will you be ready to go to work ? "

" Now," answered Edison. A few hours later he had commenced and was assigned to night duty. His future colleagues in the telegraph office decided to have some sport with this ill-clad ' Western guy,' and put their heads together to do it properly, in a thoroughly artistic manner. They told him to sit down at a particular table and receive a special report for *The Boston Herald.* Edison took his seat without the least suspicion.

In later years Edison enjoyed relating this amusing story, which turned singularly to his own advantage. The conspirators had arranged with one of the most skilful operators in New York to send the dispatch with disconcerting speed, in order to ' salt ' the new man. The New York sender did his best. He began fairly fast, but continued to send

faster and faster. Edison adapted himself without the least trouble to this increasing speed; he employed a form of vertical handwriting, in which he excelled and which permitted him to transcribe with a maximum of rapidity that was unknown in Boston. His dexterity at first served only to increase the efforts of the New York sender, but with no different result. Hereupon Edison became aware that the accomplices were watching over his shoulder, with a growing amazement at the speed of his pen and the clearness of his writing. He understood the trick, and pursued his task unconcernedly, giving no sign. Then the man in New York began to run the words together, and confuse the signals, but all to no purpose. Edison was in the habit of interpreting the most defective messages as well as any others. He contented himself with telegraphing: "Listen, my young friend, change off and use your other foot." The other, much chagrined, had to abandon the joke.

In this way, by being quicker with his fists, in both the literal and figurative sense, Edison won his fight for the esteem and confidence of his colleagues. Thereupon he

returned to work with all the greater courage and with that amazing power of endurance which is decidedly one of his most characteristic traits. At night he fulfilled his routine duties, which no longer contained unsolved problems. In the daytime he buried himself in Faraday's *Experimental Researches in Electricity*. Faraday, whose works were then far too little known or understood, opened up new horizons. Edison gave himself up to this line of reading and to his own reflections with such passionate absorption that he forgot to eat, drink or sleep. He said to his friend Adams, who 'roomed' with him: "Adams, I have so much to do and life is so short! I am going to hustle!"

Edison's long reflections on scientific problems did not prevent him from living wholly in the midst of reality; and the reason why he became a devoted admirer of Faraday was precisely because Faraday did not employ the methods of mathematicians, but that of experimenters, which, according to Edison, is the only true one. He continued to amaze all who knew him by his extreme ingenuity, which was always ready to be called into action, and in the most widely diverse fields.

Thus, for instance, when he found that the walls of the Boston offices were infested with cockroaches in spite of all that could be done, he proceeded to exterminate them by means of electric batteries. This feat earned him a publicity which he was more anxious to acquire by a different order of exploits, more worthy of fame and fortune.

It was precisely at this epoch—the 1st of June, 1869—that he took out his first patent, for a voting machine, on which he had been working for several months. The object of this machine, which was never put into use, was to obtain a practically instantaneous vote, accurate beyond the possibility of contest, in any deliberative assembly. The oscillation of a needle to the right or to the left recorded the ' aye ' or ' no ' of the member voting. An electric current registered this vote by discolouring a paper impregnated with a certain chemical composition. Thanks to this same current, the number of ayes and noes was displayed automatically upon a bulletin board. This device was intended for use in Parliament and Congress. But, apart from the fact that it prevented fraud, it had a number of inconveniences. In fact,

by permitting each member to vote privately, it did away with discussions before the vote was taken. Messrs Dyer and Martin, who give some valuable details regarding this curious machine,[1] record the significant remark made by an important member of the committee to which it was referred, at Washington: "If there is any invention on earth that we don't want here, it is this. One of the greatest weapons in the hands of a minority to prevent bad legislation is filibustering on votes, and this instrument would prevent it." Such was the verdict of a professional politician, which the young inventor must have pondered over, not without some bitterness, while he promised himself that he would henceforth adapt himself more and more, better and better, to the clearly expressed needs of the public.

We shall see that Edison continued to prosecute his experiments in chemistry and electricity, and that from this time onward he was marvellously successful in making the former come to the aid of the latter. He and one of his associates amused themselves by manufacturing chemical compounds.

[1] *Life of Edison.*

Thus it happened that, having found the formula for making nitro-glycerine, they undertook one day to make some. But, as a matter of fact, they were so frightened to find themselves in possession of an explosive of such a dangerous nature that they hastened to put their product into a bottle, wrap their bottle in a paper and throw the whole very cautiously into a sewer.

There are several amusing anecdotes regarding Edison's life in Boston, in company with his friend Adams, a singular individual, richer in ideas than in money. A well-known public man who knew Edison at this period pictures him as fertile in ideas, but of uncouth manners and lacking in all niceties of dress. Without stopping to comment upon those characteristics, we must not fail to relate an episode that is not without its humorous side.

A good deal of interest was being taken in Boston in the life and inventions of Morse. The principal of a certain school applied to the offices of the Western Union for a lecturer well versed in the subject and capable of holding the interest of an audience of young people. Edison, being recommended, accepted with pleasure, all the more because he

was delighted at the chance of augmenting his salary from outside sources, which would permit him to indulge himself more extensively in experiments and in his taste for books. It is said, however, that he was so absorbed in his various problems that he forgot the hour of the lecture, and that when his friend Adams looked for him to remind him, Edison was found on the roof, busily engaged in putting up a telegraph wire. It would be rash to guarantee the absolute authenticity of this statement. But however that may be, without changing his clothes, Edison, accompanied by Adams, who helped him to carry the apparatus necessary for illustrating the lecture, took his way to the school. Imagine his stupefaction when he found himself in the presence of a score of young girls, all dressed in their very prettiest frocks! But after a few moments of embarrassed silence he began to speak, and, thanks to his thorough knowledge and perfect clearness, he obtained a genuine triumph.

The main point in connexion with this anecdote is that it proves what a well-established reputation this experienced young operator already enjoyed in such a city as

Boston. It also serves to show in what direction Edison's thoughts were tending. In spite of his manifold projects, his diverse inventions suggested by reflection and by circumstances, it was not in vain that he had bestowed minute and persistent attention upon the manipulation of the telegraph. He had in his hands an instrument the possibilities of which seemed to him to be marvellous, but which he judged to be still in a very rudimentary state. Morse had constructed the first telegraph line in 1843, between Baltimore and Washington. In 1869 Edison felt sure that he had discovered the improvements necessary to perfect it. It was not a question of interfering with the fundamental principle of telegraphy, but simply, given this principle, of deducing from it all the practical results. Now Edison had immediately realized the extreme value of discovering a way to send two dispatches, or even four, in place of one over the same wire at one and the same time.

This idea was the origin of his duplex and quadruplex telegraphy. Having gathered together the sum of eight hundred dollars, he made his first attempt at duplex telegraphy

with an apparatus of his own construction, over the telegraph line connecting Rochester and New York. The attempt was unsuccessful because his assistant had failed to understand and follow out his instructions. This set-back did not in the least discourage the inventor, but he saw the necessity of removing to New York, where he would have far greater opportunities of exploiting his discovery. Would it not be worth millions to the telegraph companies of the New World, and quite as much to those of the Old World as well? And was it not quite legitimate that his labours should bring him the necessary means for pursuing his researches in peace?

But Edison had not yet climbed his Calvary, the Calvary of all inventors, even those whom chance, aided by their own endeavours, seems determined to favour. He had exhausted his resources. When he took the boat for New York he was literally without a remaining penny, besides having to leave behind him in Boston his instruments, his books and his few other modest possessions. His first thought when he landed in New York was to get breakfast. An operator whom he knew lent him a dollar. The problem

which he then confronted seemed for the moment more important than all others, for he was famished: what should he eat. He decided to take an apple dumpling and a cup of coffee—a repast which tasted at the time absolutely delicious. Mr Edison is a moderate eater, for he has suffered from stomach troubles; but he is not averse to the delicacies of the table. In the midst of his superbly appointed home at Llewelyn Park does he ever look back, we wonder, to that first feast of his after arriving in New York?

After finding a tolerable lodging, his next need was some immediate occupation by which to support himself while waiting for an opportunity to make his discovery known and reap a substantial benefit from it. Once again there has been no lack of attempts to exaggerate the straitened circumstances of this young inventor of twenty-two, by prolonging them over a period of several weeks and then, at a single throw of the dice, transforming him into a veritable Pactolus.[1] The

[1] A river in Asia Minor in which King Midas bathed in order to remove the unwelcome power of the 'golden touch' with which he was afflicted. Since that time "Pactolus singeth over golden sands."

simple truth is quite sufficiently interesting and dramatic to be adhered to, just as Edison himself relates it, without any useless embellishments. In New York he had applied without delay at the offices of the Western Union for a position as telegraphist. Meanwhile, by a stroke of luck that was destined to bear most happy results, he obtained employment with the Gold Reporting Company.

The same Dr Laws who afterward became president of the University of Missouri, and was distinguished as an engineer and electrician, had patented an instrument of his own invention, the Gold Reporting Telegraph, a patent which he was then successfully exploiting. During the Civil War the national debt had greatly increased and the price of gold had risen to a high premium; consequently the value of all other commodities varied according to its fluctuations. The telegraphic device of Dr Laws had for its object the transmission of the price of gold to the offices of all brokers and money-changers. The commercial life of the big city was subordinated to this rise and fall, and to the information sent out from the

office of Dr Laws. The least disturbance of the machine meant business and financial stagnation. Let us follow the story as told by Edison himself.

On the third day after his arrival in New York, while he was sitting in the office, this extremely complicated instrument, which was responsible for the transmission of dispatches all over the city, and which made a deafening noise in doing so, suddenly stopped working, with an ominous crash. The tumult that resulted was indescribable: three hundred brokers' clerks burst into the room, which was hardly capable of holding one hundred, every one of them adding to the hubbub, and every one of course wasting his breath. Edison examined the instrument and quickly saw what the trouble was: a contact spring had broken and had dropped down between the two gear wheels, thus preventing them from turning. There was nothing serious the matter. He was on the point of giving the necessary instructions to the man in charge of the machine, who had completely lost his head. But at that moment Dr Laws himself made his appearance in a state of the greatest imaginable excitement. When

questioned, the man in charge only stared in open-mouthed silence. Edison then spoke briefly, giving the explanations asked and pointing out the repairs to be immediately made. Two hours later the precious instrument was once more working to perfection. Dr Laws questioned this well-informed operator who had saved him from his difficulties and asked him to call at his private office the following morning.

Edison did so, and before the interview was over it had been agreed that he should have the superintendence of all the machines in the establishment, at a monthly salary of three hundred dollars.

Three hundred dollars! At that time it seemed a fortune to the young man. The bargain was profitable to them both, for Edison made some advantageous improvements, and at the same time had abundant opportunity for pursuing his personal researches. Furthermore, he was now relieved from poverty and anxiety. He was free to follow his chosen path to fame and progress. The rapidity of his advance was almost unparalleled, although it could hardly be said to have been unforeseen, because his courage,

his energy, his extreme cleverness in taking advantage of circumstances and seizing the opportune moment give to Edison's creative genius a prodigious advantage which easily explains his most astonishing results.

Henceforth Edison was no longer content merely to solve the problems that ceaselessly presented themselves to his ever-alert mind; he wanted, in solving them, to benefit largely by the results. And since he applied himself to questions that most directly concerned the big industrial and financial movements that were taking place in the United States, and especially in such a centre as New York, he was able within a few months to bear off the proud trophies of reputation and money. Money, above all, is the indispensable equipment of the inventor, whose expenses are, one may almost say, as limitless as his conceptions, in which dreams must constantly play a part until such time as they are transformed into realities—realities that often are promptly assumed to be indispensable necessities in a state of society that is eager to enjoy all the benefits of civilization. Besides, that period of financial crisis was

favourable for the development of new ideas that answered to the immediate needs of banks and commercial houses. And it is well known what formidable intensity they assume in the land of dollars, where fortunes are built up and lost again with dizzy rapidity.

Thanks to the improvements made by Edison in the gold indicator, and in a measure to the position he now occupied, he was brought into continual relations with a young engineer of the highest merit, Mr Franklin L. Pope, who later became President of the American Institute of Electrical Engineers. The two men were quick to understand and measure each other. Together with a publisher, Mr J. N. Ashley, they formed a firm known as " Pope, Edison and Company, Electrical Engineers and General Telegraphic Agency." They opened their office in New York in October 1869. They offered their services to all persons desirous of applying electricity to the arts and sciences, and of learning what instruments were necessary and how to use them. The company undertook the construction, maintenance and repair of wires, cables,

batteries, etc., in short, of all forms of telegraphic apparatus, and would also furnish all necessary drawings, engravings and catalogues.

Meanwhile the Gold Reporting Company had undergone considerable development and had been merged with another company and become the Gold and Stock Telegraph Company, under the direction of General Lefferts. Edison was entrusted with the installation of various private lines. Meanwhile he had been seeking methods for obtaining the more rapid transmission of dispatches, and these improvements had brought about an important change in the order of things. He also invented a new telegraphic printer, or 'stock ticker,' to record the current price of gold and stock quotations — and this invention also was taken over by the company.

After this he proceeded to multiply his inventions of contrivances to be applied to telegraphy, and obtained patents of them which secured him in his rights. One day General Lefferts summoned the young inventor to his office.

"See here, young man," he said, "I want

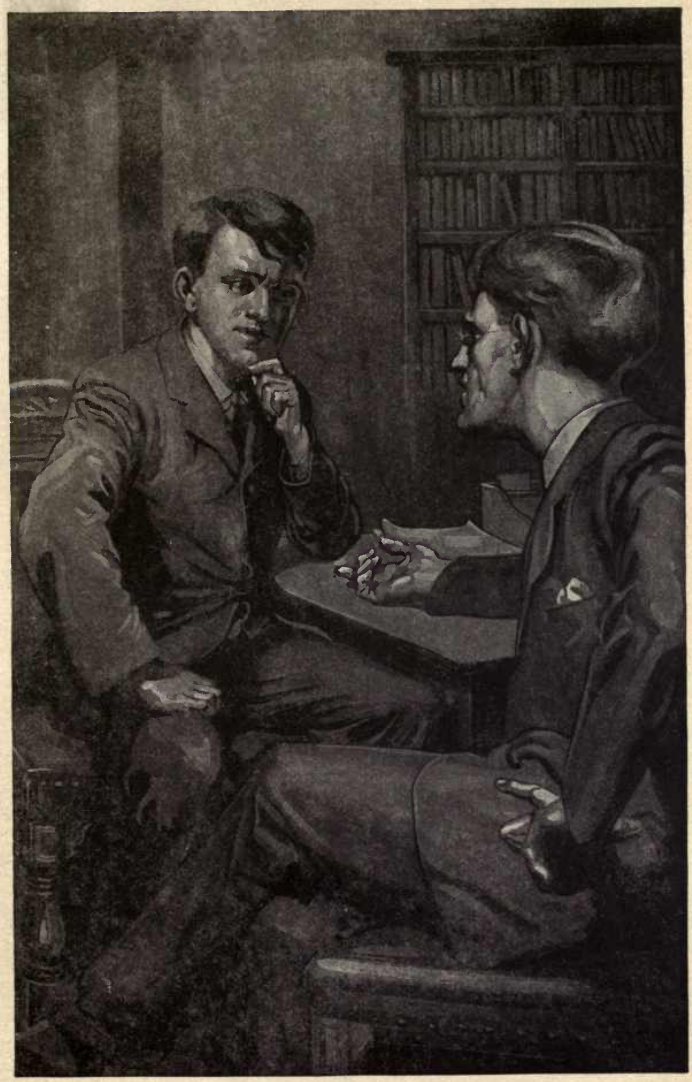
the entire lot of your inventions. What will you take for them ? "

Edison, who had previously made a calculation based upon the time he had spent, and also upon his desire to be at liberty to occupy himself exclusively with his personal researches, was vaguely dreaming of an outside sum of five thousand dollars, and a minimum of three thousand. But, brave as he usually was, he did not dare to put such a sum into words, so he contented himself with replying :

" Make me an offer, General, and I will consider it."

" What would you say to forty thousand dollars ? "

At this point Edison, who has himself narrated the incident with much humorous appreciation, admits that he came very near fainting. His heart began to beat with such violence that he was almost afraid that the General would hear it. He contented himself with replying that he thought the offer was a fair one and that he would accept it. With a satisfied " All right," General Lefferts assured him that the contract should be prepared and signed within three days



"'WHAT WOULD YOU SAY TO FORTY THOUSAND DOLLARS?'"

and that he should receive the money at the same time. In spite of all his self-possession, Edison could not help feeling that he was taking part in a dream—a very beautiful one, but none the less only a dream. However, the contract was duly presented to him and he signed, without even looking at it. How many authors have celebrated, with all the magic of their loftiest style, the memory of their first love! Should there not also be a place, in the positivism of our present century, for glorifying the memory of the first cheque received? At all events, young Edison was in a state bordering upon intoxication as he made his way to the Bank of New York.

At the paying teller's window, where he presented his cheque—the first, as a matter of fact, that he had ever received—a brief remark was addressed to him which his deafness prevented him from understanding. In some anxiety he returned to find General Lefferts, who, after enjoying a good laugh, instructed the young scientist in the art of endorsing cheques. Accompanied this time with a clerk instructed to identify him, he once more sought the paying teller's window.

After a little good-natured joking the entire sum was handed over to him in a mass of bills which he had great trouble in stowing away, with infinite precautions, in his various pockets, those of his overcoat included.

Without being a miser, Edison found himself unable to sleep, because of the thought that he might be robbed. For did not this money mean freedom from drudgery, a soaring flight opening before his genius, which had decreed the advent of a new era, thanks to the fairy power of electricity ?

Once again the General came to his aid, finding much amusement in the trials of a man of science who was so unfamiliar with banking operations, and he gave Edison the friendly and wise advice to deposit his money and open an account.

We shall soon see that Edison was no more capable of sleeping upon his laurels than upon his money. He had got what in sporting parlance is called his ' second wind.' Henceforth, thanks to an intense, inexhaustible, miraculous activity, this great conqueror of modern times was destined to speed onward from victory to victory.

## CHAPTER III

EDISON THE NAPOLEON OF MODERN TIMES—THE FAIRYLAND OF MENLO PARK—EDISON AT WORK AND EDISON AT PLAY

EDISON was incapable by nature of stifling the interior flame and contenting himself with a gilded mediocrity. His good fortune did not intoxicate him, but it augmented his audacity and increased his energy.

The hour had struck when he was to act for himself, following his natural bent. At last he could work as he pleased, elsewhere than in a blacksmith's shop, a cellar, the corner of a bed-chamber! Eager to exploit his new inventions, he hired a shop, bought machinery, installed a laboratory containing all the apparatus necessary for his experiments in physics, chemistry and electricity. This shop soon became too small. He found another in Newark, New Jersey, a large four-story building situated in Ward Street, that is to say, in the business centre. The rent of

such a building was, as may be imagined, considerable. But men like Edison do not care to play for small stakes; they are so constructed that they take no interest unless the game runs high. Since he had not tried to economize, he was not surprised to see his money disappear little by little. He was sowing in order to reap, and the harvest proved most bountiful. General Lefferts gave him big orders for stock tickers, and before very long he was employing over fifty workmen.

It should be observed at once that Edison, like all great conquerors, is an admirable manager of men. He is able to communicate his enthusiastic ardour to all who surround him, or who are in touch with him, whether from near or far. His power of persuasion is fully equal to his power of work. He is astonishing as a great inventor; but as a great manufacturer and director he commands no less admiration. If he has promised to deliver certain apparatus within a brief space of time, he will easily remain twenty-four hours consecutively at the breech, in the midst of his subordinates. Two or three half-hours of sleep suffice to

leave him once more fresh and alert. His mental vigour is supplemented by a physical vigour of a rare, not to say unique, character.

From the year 1869 down to the present date Edison has taken out something like fourteen hundred patents in the United States alone! Yet, with characteristic caution, he has refrained from patenting all of his inventions.

Unquestionably he has a gift for surrounding himself with chosen men, of picking out those of special promise, and it may be safely asserted that a majority of the eminent electricians in America have served their apprenticeship under Edison before going forth in their turn to teach the theory and practice of their science.

The co-operation which he thus secured, thanks to his extreme clairvoyance, has enabled him to build up a vast organization. Without detracting from the merit of all the others who have had a share in it, we must nevertheless recognize that it remains the fruit of his own unequalled initiative. It is like the limbs of the body which act in obedience to the commands of the brain.

It is very difficult, if not impossible, from

1870 onward, to follow Edison step by step, from discovery to discovery, from business venture to business venture, because of the vastness and complexity of his activity and the diversity of his occupations and preoccupations. It is his habit to carry forward simultaneously a number of different tasks in his varied capacity of physicist, chemist, and business man. He invents an instrument, then abandons it in order to give his attention to some other project which haunts his thoughts, then presently reverts to the instrument in question, transforming and perfecting it. Then he seems once more to forget it, but only to come back to it, ten or twenty times, without ever becoming tired of seeking and finding.

His success as a manufacturer was rapid and continuous. Circumstances favoured him quite as much as his audacity and perseverance. Fluctuations on the Stock Exchange and the fever of speculation in New York brought a steadily increasing profit from the manufacture of his stock printers.

Following the example of the Gold and Stock Telegraph Company, other equally powerful organizations, such as the Auto-

matic Telegraph Company and the Western Union, applied to him for new and improved telegraphic apparatus. These profitable contracts, the due and timely fulfilment of which required much care and forethought, did not prevent Edison from devoting himself especially to the problem of double and quadruple transmission, as well as to the automatic telegraph. Before long he had achieved practical results which the professional operators were quick to appreciate, and which the public Press of New York seized upon as an occasion for singing the praises of this young and talented inventor. The former newsboy and fruit vendor of Port Huron had not needed to await even his twenty-fifth year before he found himself rich and widely known.

It was these same famous researches of his in the field of electricity as applied to telegraphy—a field which, up to that time, had been little explored—which in 1873 enabled Edison to make a contract with the two powerful New York companies, by the terms of which he agreed, in consideration of a considerable sum, to give them the first option on all his new telegraphic appliances.

This contract was a veritable source of life and prosperity for his enterprises. His shop became a manufactory which, from 1873 onward, employed three hundred workmen. His character at that time as director-in-chief was extremely original. He broke with all customs and traditions, and manifested an independence which gave a flavour of individuality to all his words and actions. For instance, he discovered one day that his head book-keeper had credited the concern with $7000, when, as a matter of fact, they had incurred a loss of $15,000. On the strength of this experience the great inventor made up his mind that book-keeping was a useless luxury and accordingly discontinued it.

Like all geniuses, Edison recognizes the value of impulse, and he has persistently mistrusted, for others as well as for himself, the influence of rules and conventions which so easily lead to inertia and routine. That is why his entire staff is modelled after his own pattern. In those workrooms where the chief object is to capture and subdue the mysterious force of electricity it seems as though every engineer and every mechanic were united by unseen currents with the

master mind. Through contact with him the humblest workman conceives a passionate devotion to the common task. He stimulates them by appealing to the heart quite as much as to the purse. He amazes them with his technical knowledge, and he obtains from them a heroic degree of effort which results in a most efficacious harmony.

In order to understand the power of this wizard it is worth while, even at the risk of repetition, to dwell emphatically upon his ability to win the admiration and devotion of his assistants. In this connexion a number of significant instances might be cited. There is one to which we must not fail to draw attention, because it is sufficient in itself to prove the authority which this extraordinary director of men already possessed, notwithstanding his youth, as well as the strange, almost alarming, vigour of his physical and moral nature. He had received an order for stock printers amounting to the sum of $30,000. The instruments, when finished, for some unknown reason, failed to work. Yet they had to be delivered within a given time, or the contract would be void.

Edison had the defective instruments

brought into his laboratory, summoned his collaborators and mechanics, locked the door, and said: "Now, boys, let's get busy; we don't go out of here until this work is done!"

There was no complaint, not even a murmur. They fell to work, and continued at it for sixty consecutive hours, hardly stopping long enough to take food. As for Edison himself, he did not waste a single moment in rest or sleep. But at the end of the sixty hours the instruments were in working order.

Where in the world could such workmen be found, except under the command of such a chief? It is said, by the way, that Edison recuperated his strength by a sleep of thirty-six hours.

The story of his first marriage, which has been very pleasantly related by an English writer, Mr Frank Mundell, is equally entertaining. While we cannot rigorously and scientifically guarantee its absolute accuracy, it does not seem to be at variance with the greater part of the deeds and actions of the illustrious king of electricity. It took place in 1873, two years after the death of Edison's

mother, who had watched with great solicitude the ripening of his intellectual powers, and had lived to witness only the earliest manifestations of his genius.

One day he paused behind one of his young women assistants, who was quite absorbed in her task, before an electric writing machine. He stood there a long time, so long, in fact, that the young girl became nervous and interrupted her work. Was she doing it wrong, she wondered, and was it the machine which had attracted the attention of the great inventor—or was it the operator? He asked her whether he had startled her. Then he perceived that what she felt was not fear, but a more tender sentiment.

"Well," he continued, "will you be my wife?" And that was how Mr Edison came to marry Miss Mary E. Stillwell.

Far from assuming a share of responsibility for this pleasant and quite electric idyll, our own belief is that the inventor required a certain degree of premeditation in the case of this discovery, just as in all his others, and that he had assured himself of the charming qualities of Miss Stillwell before deciding to make her the partner of his hard and

laborious life. Yet we could not forgive ourselves if we failed to relate the sequel to this picturesque recital, notwithstanding that Mr Mundell himself admits that his version rests upon hearsay evidence.

At all events the story goes that on the evening of his wedding, at a very late hour, a friend of Edison's passed by his laboratory. To his great surprise he perceived gleams of light filtering through the window blinds. He entered the isolated building and found the scientist absorbed, as usual, over an experiment.

"Look here, Tom," he said familiarly, "what are you thinking of? It is past midnight. Aren't you going home?"

"What, is it as late as that already? Past midnight! How extraordinary! And, now that I think of it, I was married to-day. Bless me, yes, I really ought to go home!"

One thing that is certain is that he found in his wife a companion who was an enthusiastic admirer of his ideas and achievements and wholly devoted to his gigantic enterprises. It could not, indeed, have been otherwise, for Mr Edison could never have endured to live outside his own sphere and

apart from the occupations to which he had wholly given himself up from the beginning. In seeing her husband at work, his wife could not do otherwise than esteem and respect him more and more, while leaving him the liberty required for that sort of fermentation of ideas which must necessarily precede their final ripening into deeds. She died in 1884, profoundly regretted by all.

After his marriage Edison endeavoured to conform a little more closely to the requirements of society by returning home at fixed hours for the purpose of eating, drinking, and sleeping, after the fashion of the rest of humanity. He did his best, but could never altogether succeed in resigning himself to abandoning his experiments when they deeply engrossed his attention. At the moment when he grasped the key to a problem, Edison ceased to belong to that social order which he has so magnificently placed in his debt.

Three children were born of the marriage, Thomas Alva, William Leslie, and Marion Estelle. He was an excellent and affectionate father, and had the habit of calling the two elder children Dot and Dash, in memory

of that telegraphic language whose secrets he had so rapidly made his own.

During the years in Newark, from 1873 to 1876, Edison came into full possession of his formidable omnipotence, due to his energy, his knowledge, and his creative genius. It seems as though, throughout those three years during which he was directing his establishment and consecrating long days and long nights to perfecting his new apparatus, he became able, after many and oft-repeated experiments, to contemplate with a profounder and keener gaze the great problem of the utilization of electric force. He passed from one question to another, with unerring glance and method, speeding ever faster along the road that leads to wealth and fame.

Surrounded as he was by an admiring public which too often sought to satisfy its curiosity at the expense of his time and liberty—both of which he has always sought to protect against the mounting tide of idle intruders—Edison dreamed of seeking a more sheltered asylum for his personal work. Although possessed of an activity surpassing that, not of one, but of several ordinary men,

he had realized the necessity of securing to himself a certain measure of isolation.

Far-sighted business man that he was, he had clearly foreseen that the sale of patent rights alone would not bring in a sufficient return to meet the needs of an inventor. Hence the rapid extension which he succeeded in giving to his manufactures within a surprisingly short time. A German writer, Herr Pahl, who has devoted an extremely interesting study to Edison, has remarked with good reason that the inventor's comprehension of modern necessities was one of his most precious possessions. In point of fact, it is thanks to his manufactures and business interests that it has been possible for him continually to supply his many needs as an inventor.

Nevertheless, since he had been able to gather around him a sufficient number of devoted collaborators of assured ability, there was no longer any real objection to shifting part of his burden.

It was in the spring of 1876 that he resolved to transfer his family residence and his laboratory to Menlo Park, New Jersey, twenty miles from New York on the line to

Philadelphia. Edison himself has given a clear and entertaining explanation of this change. His words have been accurately reported by his friends and brilliant interpreters, Mr F. L. Dyer, the lawyer, who has full charge of all his legal interests, and Mr T. C. Martin, former president of the American Institute of Electrical Engineers, who furnish us, in the course of their study, with all sorts of enlightenments of inestimable value.

Edison relates that he had occasion to rent by the month a small office situated in a huge building used for the manufacture of padlocks. He gave notice, at the end of a certain month, and, having paid his rent, went off, leaving the keys behind him. Shortly afterward he received a legal notice requiring him to pay an additional nine months' rent. It may have been in accordance with the law, but it seemed to him so unjust that he made up his mind to leave a locality in which such an outrage was tolerated.

On the other hand, there is no doubt that the great inventor found all sorts of advantages in transferring himself to Menlo Park. Before choosing this particular site he had made excursions for a number of

successive Sundays. He wanted to be quite sure that he had a certain number of conveniences within easy reach.

It proved to be a happy choice. During the period from 1876 to 1886 Menlo Park was destined to be a unique centre, mysterious and colossal, animated by the astounding genius of this American whose fame had radiated throughout the length and breadth of the Old World with a brilliance unsurpassed by his own electric light and dazzling all eyes as it shone through the surrounding shadows. For Edison is a sort of modern Faust who has passed into legend not merely during his lifetime, but in the fullness of youth and in his singular, unparalleled maturity; and he was destined before long to be known as the Great Wizard of Menlo Park.

To-day that famous laboratory and those machine shops which the master had animated with his intense ardour and prodigious will-power have fallen into silence. They are buildings without a name and seem to have retained no memory of their former glory. Edison, to be sure, has since chosen another battle-field for his peaceful victories.

Nevertheless it was at Menlo Park that his

fertile genius brought into existence a horde of amazing productions, ranging from the carbon transmitter to the phonograph, from the incandescent lamp to the apparatus for electrical distribution, to the megaphone, the taximeter, and the electric street car. It was also in Menlo Park that, while perfecting his instruments for multiplex transmission, he laid the foundation for wireless telegraphy, thus uniting the past with the future.

Just as he unhesitatingly transformed his first cheque for forty thousand dollars into an establishment where he would be free to work as he chose, so at a later period he made use of the four hundred thousand dollars of net profits resulting from the three years spent in Newark.

Before long the new buildings, of modern and comfortable design, had begun to rise. Edison was at last going to have a laboratory worthy of him, equipped with all the necessary appliances and all the innumerable substances which a wizard of science might want. It is said that he spent one hundred thousand dollars just for the physical and chemical apparatus.

There were seven buildings. Edison in-

stalled himself in one of them, while three of the others were occupied by his assistants and their families. The rest were reserved for the laboratory and machine shops. The office was originally installed in a two-story woodens tructure, but was afterward transferred to the library building, which was built of brick.

The laboratory, from which issued all the marvels begotten by Edison's daring, yet at the same time patient, genius, was situated in a sort of hall about one hundred feet long by thirty-five wide. Here one might see tables covered over with phials and test-tubes and instruments of the greatest variety, and, further on, a collection of the rarest metals—also an organ, for the inventor of the phonograph is a great lover of music.

There were, in addition, separate rooms devoted to the galvanometer, the photometer, the electrometer, a carpenter shop and a vast hall for machines of various dimensions. The lighting system, which was originally gas, was destined to be replaced, and rightly so, by the incandescent lamp.

It is no more than just to make mention of the names of Edison's principal collaborators,

who so gladly gave him the aid of their zealous collaboration and often their rare and special knowledge; it is only fair that, after having had the toil, they should now receive the credit.

In the foremost rank should be mentioned Mr Charles Batchelor, his chief assistant, who participated in many of his inventions and who entered his service as early as 1870. Mr Batchelor is an Englishman, a mechanic of rare attainments, loyal-hearted and with an intelligence as alert as his fingers are dexterous.

Mr Francis Upton, another of his principal collaborators, was a mathematician and scientist of considerable distinction, who had completed his studies under one of the greatest of all masters, Helmholtz. Edison, who before all else is a practical worker, whose starting-point is experience and experimenting, while sincerely admiring Mr Upton, freely laughed at some of his fine theories and did not hesitate to replace his calculations with actual facts that were more directly helpful.

Conspicuous among the other pioneers of the New World created by electricity were

Messrs William J. Hammer, Martin Force, Francis Jehl, who has given a most interesting account of his life and experiences at Menlo Park; John Kruesi, a mechanic of rare skill; C. T. and S. D. Mott, Dr E. L. Nichols, Mr Isaacs, the photographer; Ludwig K. Boehm, who throughout long and studious evenings used to sing and play his guitar for the entertainment of his comrades; S. L. Griffin, Edison's old telegraph friend, who now acted as his secretary, and Professor MacInry, who with two assistants undertook to make the necessary public demonstrations of the new inventions and their manipulation, etc.

At Menlo Park there was a constant coming and going of visitors from every country of the Old World as well as of the New. Artists there met and mingled with scientists, professors, engineers and mechanics, all eager to draw inspiration from this same mighty fountain-head.

Edison continued to set an example of dogged industry. When he was following up a course of experiments he would not stir from his laboratory, but slept upon a table. A few books served him for a pillow. This improvised bed satisfied him admir-

ably, for he was able to sleep at no matter what hour, quickly and soundly, without dreams.

In the midst of his comrades he habitually was and still is delightfully good-humoured. At Menlo Park, after luncheon and a cigar, it was the habit to indulge in a short session of music and entertaining stories. Edison enjoyed a hearty laugh, and he was delighted when he drew an answering laugh from men who were ordinarily so serious and so profoundly absorbed in their common task.

Among his visitors, in addition to intimate friends like Mr Johnson and the learned Professor Barker, there were strangers who were destined later to carry Edison's processes to nearly every country on the globe: such men, for instance, as M. Louis Rau, a Parisian, the founder of the Edison Company in France, Professor Colombo and Signor Buzzi, who organized the Italian company, and Herr Rathenau and Herr Fodor, who came respectively from Germany and Hungary. We might also have met there some old-time acquaintances, among them Edison's father, a rugged and highly respected patriarch who

came to enjoy the spectacle of his son's glory ; and MacKenzie, the former station-master at Mount Clemens, also enjoying himself in a hearty and jovial way.

Menlo Park developed rapidly, and little by little Edison made it the centre even of his business transactions. Later on he constructed an electric railway in order to facilitate enjoyable trips through the neighbouring woodlands.

Here was the scene, here was the stage-setting where the great wizard carried on his strange communions with the forces of nature, which he knew how to control, thanks to his power of penetration, his power of taking in with one and the same glance the most diverse elements, of seeing in the midst of widely dissimilar phenomena the secret laws which govern them and which must be subjugated to the needs of victorious man.

What a host of pleasant memories Menlo Park must have left in the minds of all these eminent collaborators of a scientist as affable as he was patient ! He astounded them with his incredible power of continued labour. He never showed an instant of weakness, anxiety,

fatigue, or nerve strain. On the contrary, while he was the first to begin work and the last to leave it, he had, nevertheless, no equal in his appreciation of a funny story, and was largely responsible for the bursts of hilarity in which the staff indulged from time to time, becoming for the moment so many grown-up children, during intervals of respite and recreation.

His one mistake was occasionally to think that everybody else was capable of physical and moral endurance such as his. He was always on foot, calm and sure of himself, when even the most valiant of the others were exhausted and sued for mercy, because they felt the need of food, drink and sleep. Yet at hours when an indispensable and final effort must be made, he would end by communicating even to the weariest something of his own energy and faith.

We are beginning to see and know the inventor, as he really is in his working clothes, greater in actual life than any fiction could make him. That is why we have tried to visualize him in the appropriate setting which he himself created with all his energy and all his faith.

The next step is to cast a glance at his discoveries, and attempt to estimate their value as well as their influence upon the grateful generations of to-day and to-morrow.

## CHAPTER IV

### DISTANCE IS ABOLISHED—EDISON STARTS UPON THE CONQUEST OF THE OLD WORLD OF EUROPE

WE have mentioned Edison's first successes as a telegraphist, and we have shown him engaged in researches after other apparatus adapted to modern needs. Although not the inventor of the telegraph, Edison discovered so many and such diverse improvements to it that he remains, in this regard, a pioneer of the first rank.

It will suffice to recall that it was he who perfected the automatic telegraph invented by an Englishman named George Little. The system had produced good results on very short lines, but it proved extremely defective in the majority of cases.

Edison and E. H. Johnson introduced modifications, the value of which was proved by practical tests. In 1872 the automatic telegraph was installed between New York

and Washington. An English company soon afterward offered to apply his methods to their submarine cables to Brazil. Edison was summoned to London and his ideas were adopted, but without his having secured any benefit for himself.

He was more fortunate in regard to his duplex and quadruplex telegraph, to which we have already made more than one passing allusion. The purpose of both these inventions was to modify the Morse apparatus in such a way as to make it possible to send more than one message at a time over the same wire. The commercial importance of these new methods was immediately recognized, thanks to the essential and definitive improvements introduced by Edison.

The duplex telegraph made it possible to send two separate messages in opposite directions over the same wire. Edison showed that a double transmission was also possible in the same direction. This change in direction was accomplished by the simple device of varying the strength of the current.

But it was the quadruplex telegraph which, in 1874, brought Edison into full publicity. By this system four messages could be sent at

the same time over a single wire, two in each direction. This method of simultaneous transmission, which has been continually made more and more practical, thanks to Edison's prolonged efforts, constituted a most important improvement. The use of the quadruplex could not fail to constitute a saving to the companies of many millions of dollars.

But before he had passed from theory to a result that satisfied his expectations, the young inventor was necessarily long absorbed in his reflections and in the patient working out of a vast number of attempts and experiments. In fact, the achievement of a quadruplex capable of realizing his dream became a sort of obsession. It was in consequence of this preoccupation that he experienced the following amusing little adventure. He was so absorbed in working out the details of his apparatus that he not only spent day after day in his Newark laboratory without eating, drinking and sleeping, all of which was, as we have seen, of little or no importance to him, but he even forgot to pay his taxes. Consequently, like any other free and equal citizen, he received a notice one day to call

the following morning at the tax collector's office, in default of which he would be liable to a surcharge, like any one else who was in arrears. Accordingly, the following morning Edison reluctantly tore himself away from his laboratory and presented himself at the City Hall, where he had to take his place in a long line of people all holding similar notices in their hands. When his turn came he was once more absorbed in the problem of his quadruplex.

"Well, well, young man," said the clerk, "pay attention. What is your name?"

But Edison was paying such profound attention—to his own thoughts—that he looked the questioner calmly in the face and answered:

"I don't know!"

Before his memory had awakened another tax-payer had taken his place. Before he worked up again in the line it was too late, and he had to pay the surcharge. But the solution of the problem of his quadruplex more than compensated him.

But to return to the telegraph. In addition to the above-mentioned inventions, we also owe to Edison the multiplex harmonic

telegraph, which succeeds by the aid of musical sounds in sending sixteen messages simultaneously, eight in each direction. Furthermore, this magician, for whom the word *impossible* really does not seem to exist, has invented a telegraph instrument for use upon railway trains in motion. The instrument is installed in one of the cars of the train, and is so constructed that the electric current passes from it to a wire suspended above the lines. In this manner messages have been transmitted from trains in motion, even when the telegraph wire was at some little distance from the lines. The practical importance of this instrument was promptly recognized; it obviously offered a most valuable means for signalling warnings of danger to and from moving trains, and thus preventing accidents in a great many cases.

Edison has transformed the telegraph into a practical and commercial instrument of wonderful efficacy, thanks to the speed with which it has made it possible to transact the business and financial relations of the entire world.

The *rôle* that he has played in regard to the telephone is quite similar. This marvel-

lous instrument, with which we should now hardly know how to dispense, and which makes it possible, through the agency of electricity, to convey sounds to a great distance, was invented by Bell in 1875. Bourseul and Reis had previously conceived the same idea, but it was reserved for Edison to develop its full resources.

He had already conducted some very important personal experiments, based upon some analogous principle, although just what this was he seems to have never been willing to reveal fully. But in 1876, while working for the Western Union, he saw Bell's telephone. It consisted of the present-day receiver and transmitter. The problem was to make it practical for current use; but, as a matter of fact, the sounds could not be heard excepting very faintly, and were interrupted by all sorts of strange noises. In a short time Edison produced his carbon transmitter, and the problem was solved. Experiments immediately proved in quite a definite manner the effectiveness of his invention.

Mr Orton, the director of the Western Union Telegraph Company, desired to acquire the rights. The inventor had ventured to

hope to receive a sum of twenty-five thousand dollars. Less timid than in those earlier days when he had sold his first telegraphic inventions to General Lefferts, he met Mr Orton's inquiry as to his price for his patent with the counter suggestion: "Make me an offer."

Mr Orton's offer was one hundred thousand dollars. Edison accepted, stipulating, however, that the sum should be paid in annual instalments of $6000. Accordingly the payments would extend over seventeen years, or throughout the entire period covered by the patent. Edison himself has since given the explanation of this clause. He knew himself only too well, and realized that he would promptly squander the entire sum on further experiments. He felt that it was wiser to provide himself with seventeen years of security.

But it was not in accordance with Edison's nature to rest content with having given the telephone its entire importance and reliability by the use of his carbon transmitter. With his magic ingenuity, he proceeded to extract from this instrument a whole series of other instruments depending upon the same

principle: such as the water telephone, the condenser telephone, the chemical telephone, the mercury telephone and the voltaic pile telephone.

On the other hand, we must not forget the electromotograph. Edison had observed the following phenomenon: when a metal pencil is brought into contact with a sheet of paper and an electric current sent through it, the surface of the paper becomes smooth and shiny where the pencil has passed. This property of diminished friction, thanks to the electric current, is the principle of the motograph. The inventor worked six years upon this problem. The electric motograph consists of a chalk cylinder, moistened with a chemical solution, and revolving on its axis. A pen, provided with a palladium point, slides over this cylinder, being drawn forward by the friction and drawn back again into position by the employment of the electric current. It is asserted that, thanks to the oscillation of this pen, Edison has succeeded, through this application of the principle of diminished friction, in sending a dispatch with the speed of twelve thousand words a minute.

Mr Orton promptly asked Edison what his price was for the electromotograph. Edison, who was acquiring a decided habit for this sort of conversation, once again replied: "Make me an offer." And once again the offer was one hundred thousand dollars. Edison accepted, on the same conditions that he had made for his carbon transmitter—that is to say, in six-thousand-dollar instalments for seventeen years. Consequently he had an assured income from the Western Union Telegraph Company of twelve thousand dollars a year for these two inventions, both covering the same number of years.

On the other hand, Edison's telephone was meanwhile making the conquest of Europe, beginning with England. Thanks to its separate transmitter and receiver, it had an unquestionable superiority. One of Edison's former associates—namely, Colonel Gouraud—who had worked with him in connexion with the automatic telegraph, now undertook to look after his interests in England. A company was formed, and a large number of machines emanating from the workshops of Menlo Park were forwarded to London.

Edison organized a corps of twenty young

electricians, whom he personally put through a severe course of training. He chose only those whom he judged capable of becoming genuine experts. In testing these chosen workmen he would place them in front of an instrument which he had put out of order by establishing a short-circuit, cutting the wires, or throwing dust into the electrodes. When the candidate succeeded in putting the apparatus in order ten times in succession, and each time within a space of five minutes, he was accepted.

Edison, who himself relates these great preparations for the conquest of the Old World, adds that at this period he received a most agreeable surprise. The Bell Company, established in England, had not witnessed without genuine alarm this American incursion into the United Kingdom. But how were they to contend against such dangerous rivals? Would it not be better to enter into negotiations with them and acquire the English rights to their methods? Consequently Edison one day received a cablegram from Colonel Gouraud transmitting the offer made by the English company —namely, '30,000.' Edison cabled back his

acceptance. When the contract arrived he was most pleasantly surprised to discover that it was not for thirty thousand dollars, but for thirty thousand pounds sterling, or approximately five times the amount he had expected.

In thus sending his emissaries to Europe, for the purpose of introducing his instruments and methods, Edison did not fail to meet with a certain number of set-backs, notwithstanding that he had at his command every legal and pecuniary means of defending his interests. For a patent right is a fertile source of losses, as well as of profits.

The Edison telephone, admirably exploited by his corps of young American electricians, wholly devoted to their inimitable chief, and looking upon Graham Bell as a sort of second Lucifer, did not fail to create a sensation.

Mr Edison himself, as well as Messrs Dyer and Martin, has not failed to recall the fact that Mr Bernard Shaw, the well-known writer, was in his younger days an employee of the Edison Telephone Company. He gave public demonstrations which were certainly not lacking in liveliness and picturesque

colouring. With his characteristic and humorous fashion of seeing and describing things, Mr Shaw gave the following amusing definition of Edison's telephone: "A much too ingenious invention, being nothing less than a telephone of such stentorian efficiency that it bellowed your most private communications all over the house, instead of whispering them with some sort of discretion!" [1]

In addition to Colonel Gouraud, several men of prominence undertook to spread abroad Edison's well-earned fame in a manner worthy of him. One of these, Mr Samuel Insull, testifies to the great interest taken by many of the most distinguished men and women of England regarding this great curiosity, the loud-speaking telephone. Mrs Gladstone, the wife of the famous statesman, spoke into the receiver, probably with considerable energy, and asked the operator at the other end whether a man or a woman was speaking, and the answer came back unhesitatingly in loud, clear tones that it was a man.

Mr Charles Edison, a nephew of the inventor, who died prematurely at Paris in

[1] From Dyer and Martin's *Life of Edison*.

1874, had also undertaken to popularize his uncle's methods in Europe. He was received by King Edward, at that time Prince of Wales, also by the King of Belgium, with whom he discussed the project of establishing telephonic communication between Belgium and England.

In the course of his labours on the telephone, Edison had observed the diverse and variable degrees of resistance offered by carbon to the passage of an electric current. This phenomenon afforded him a basis on which to create his microphone, the purpose of which was to give back sound in an intensified form. The microphone reproduced the faintest murmurs greatly magnified. The sensitiveness of this instrument is so great that the walking of a fly can produce the effect of soldiers on the march, and a mere rustling becomes transformed into a raging tempest.

When in the course of time Edison turned his attention to the cinematograph, he was obliged to take a different class of phenomena for his starting-point, but there was a certain analogy between the two conceptions. Meanwhile the microphone gave rise to a

very keen rivalry and prolonged controversy between Edison and the English professor, Hughes, who claimed that he had invented the instrument.

The tasimeter, or microtasimeter, belongs to the same series of inventions as the microphone. It was destined primarily to measure the smallest perceptible differences of pressure. It depends upon the same principle as the microphone—namely, that when a piece of carbon is brought into contact with another piece of carbon, or any other conductor, the slightest relative displacement of these conductors is sufficient to change the degree of resistance in a notable degree. The tasimeter consists of two platinum plates separated by a carbon disk, against which they are held by the outside pressure of pieces of rubber. Heat, by expanding the rubber, increases the pressure upon the carbon and thus diminishes the resistance to the electric current, while cold on the contrary increases it. An extremely sensitive galvanometer registers these changes in the current.

The slightest modifications in temperature may thus be registered. The instrument is sensitive to the heat of the human body or

of a cigar at the distance of ten feet. On the 9th of July, 1878, during a total eclipse of the sun, Edison demonstrated at Rawling, Wyoming, the value of his tasimeter for noting the differences in temperature of the different rays of the sun.

But, even aside from astronomical observations, it is easy to realize the many important uses to which this instrument could be put; such, for instance, as that of detecting a sudden outbreak of fire in a building, or of determining the position of an iceberg at sea.

But it is impossible to dwell in turn upon each and all of Edison's remarkable inventions. The more important have overshadowed the lesser ones, which nevertheless retain their own interest and value and would have been sufficient in themselves to establish the fame of many another inventor.

The year which we have just mentioned, 1878, coincides with the date of the birth of one of the most curious manifestations of Edison's genius. We may also say, one of the most flamboyant manifestations, since it proclaimed more loudly and more widely than ever the name of Edison. The invention in question was the phonograph.

## CHAPTER V

RECORDING THE VOICE—IS IT A VENTRILOQUIST?—GLORY AND HARMONY IMPRISONED IN A CYLINDER

ON a certain morning all Paris was informed that the extraordinary 'M. Eddison' had ceased to belong to himself and had become the property of a certain telegraph company which had installed him in a magnificent hotel in New York, where he lived in unimaginable luxury, and that the aforesaid company paid him an enormous salary in order to reap the sole profits from all his discoveries. Guards were hired to watch over him, and never leave him alone, either at meals, or in the street, or in his laboratory. Consequently, this 'M. Eddison' was a greater slave than the worst of criminals. He could not devote a single instant to his private affairs without one of his guards immediately calling him to order. He was the inventor of an instrument which would make the human voice audible

at the distance of two miles. This was made possible by the aid of a jet of steam; and a friend, if notified beforehand, could reply by the same method. It was after this fashion that *The Figaro*, following the example of many another quite serious paper, made sport of Edison in the year 1878, in an ultra-American and quite misleading manner.

It was excusable, for this man, barely thirty years of age, had just invented the phonograph, a unique and prodigious instrument, well fitted to arouse throughout the entire world the greatest surprise and admiration.

The phonograph! The talking machine, which records sounds and preserves them in their integrity for the benefit of to-morrow, the day after to-morrow, and the future centuries! Was there not an abundance in this thought to stir the heart and the brain, and to open up immense and infinite horizons to the dreams and ideals of all future generations?

The phonograph! Henceforth the secret contained in words which translate the thought, whether that thought be poetic, religious, social, or musical, could be taken

prisoner by this impassive and unerring witness. By creating the phonograph, by perfecting it, by adapting it to the needs of science, Edison had made himself more than ever an object of profound interest to the intelligent and the curious alike.

It seems as though the last word has been said in regard to the phonograph ; nevertheless, we never tire of telling it over again, with a sort of joyous and triumphant inebriation. For, if the phonograph records our voice, our eloquence, the most intimate expression of our joys and our anxieties, we certainly have the right of recording in our turn this wonderful victory of life over death and oblivion.

What a revelation it would be to us (and why should not we express in our turn this oft-repeated regret ?) if we could hear, for instance, the Sermon on the Mount, or the *Apology* of Socrates, a harangue by Mirabeau, or a Proclamation by Napoleon !

What a dream it would be to conjure up the personality of Shakespeare or Molière, while we listened to their rendering of their own works, or tranquilly to compare the voice of Talma with that of Mounet-Sully or of Max !

Let us, in any case, return thanks to Edison for affording us the pleasure of enjoying the powerful voice of Caruso and the melodious sounds that could emanate from no other violin than that of Kubelik.

Let us record at once, in this connexion, that almost from the moment of this miraculous discovery, which invested his personality with a mantle of wizardry, Edison already foresaw the various possible applications which might be made of his phonograph.

As a matter of fact, he enumerated them in *The North American Review* as early as 1878, and in view of what the closing years of the nineteenth century and the opening years of the twentieth have brought, we cannot help feeling that the list was singularly prophetic.

"Among the many uses to which the phonograph will be applied are the following:

"1. Letter-writing and all kinds of dictation without the aid of a stenographer.

"2. Phonographic books which will speak to blind people without effort on their part.

"3. The teaching of elocution.

"4. Reproduction of music.

"5. The 'Family Record'—a registry of

sayings, reminiscences, etc., by members of a family in their own voices, and of the last words of dying persons.

"6. Music-boxes and toys.

"7. Clocks that should announce in articulate speech the time for going home, going to meals, etc.

"8. The preservation of languages by exact reproduction of the manner of pronouncing.

"9. Educational purposes; such as preserving the explanations made by a teacher, so that the pupil can refer to them at any moment, and spelling or other lessons placed upon the phonograph for convenience in committing to memory.

"10. Connexion with the telephone, so as to make that instrument an auxiliary in the transmission of permanent and invaluable records, instead of being the recipient of momentary and fleeting communication."

Edison thought, at one and the same time, of the utility and the entertainment to be derived from the phonograph, its possibilities for training the mind as well as for affording an unforeseen and agreeable pastime. With the perfected instrument, we have made a

vast advance upon the humble parrot, which was Robinson Crusoe's sole consolation on his desert island!

On 24th December, 1877, Edison applied to the Patent Office at Washington for a patent, which was granted him, 17th February, 1878.

But what was the origin of this invention? Edison, as we have already shown, has in general more faith in patient and methodical research than in sudden illuminations. The phonograph, nevertheless, is the fruit of a sort of flash of inspiration, although naturally Edison had to work a long time to complete his first idea and little by little improve the original machine. For instance, in June 1888—that is to say, more than ten years subsequent to his first patent—we find him spending five consecutive days and nights in perfecting his primitive type of wax cylinder.

But the idea of the phonograph itself came to him suddenly and without effort. For, as a matter of fact, all his previous labours had formed a singularly fitting preparation for the conception of this wonderful talking machine.

Already, while working upon his automatic telegraph and causing strips of metal, marked

with dots and dashes in relief, to pass very swiftly beneath a steel point, he had noted the following phenomenon: the vibration of the steel point, as it came in contact with the dots and dashes, produced certain distinctive sounds. On the other hand, through his experiments with the telephone, Edison had proved the power of the diaphragm to catch the vibrations of sound. He said to himself that if he could find some practical way of recording the movements of the diaphragm, he would be able to reproduce the original movements communicated to the diaphragm by the spoken word, and consequently would be able to record and reproduce the human voice.

But we must go to Edison himself to learn the genesis of his invention, rather than trust to the more or less fantastic narratives of other writers. Yet it is not surprising that the imagination is inclined to make a myth out of this prodigious creation.

In the beginning, instead of employing a disk, Edison conceived a little machine consisting of a cylinder with a narrow spiral groove covering its surface like the thread of a screw. With the aid of a sheet of tinfoil

he caught and recorded the movements of the diaphragm.

When a rather rough design of the instrument was first shown to his assistants, they could not restrain their laughter at the idea of this fantastic dream of building a machine that could talk. Even Edison himself entertained no great hope of success when he asked his collaborator, John Kruesi, to go ahead and construct the machine. Kruesi, for his part, did not attempt to hide the fact that the whole project seemed to him absurd.

But when this rudimentary machine was completed, and the sheet of tinfoil had been adjusted, the inventor proceeded to recite into it the familiar nursery rhyme: "Mary had a little lamb." Then he adjusted the reproducer and the machine promptly proceeded to echo back his words. Everybody was astonished. At the first attempt the success had been unmistakable and overwhelming. "*Gott in Himmel!*" cried Kruesi, and the whole night was spent in singing, talking, and reciting into the instrument. This first phonograph is now to be seen in the South Kensington Museum, at London.

THE FIRST PHONOGRAPH 126

The news of the invention spread throughout America, arousing astonishment, enthusiasm and scepticism, after which it proceeded to encircle the globe. It was looked upon as a sort of sleight-of-hand or ventriloquism, notwithstanding Edison's insistence upon the simplicity of his machine and the absence of all element of mystery. It was exhibited by Edison himself before President Hayes at the White House ; and he also gave exhibitions of it at Menlo Park.

But let us once more permit Edison to speak for himself, as recorded by Messrs Dyer and Martin, who give some curious details concerning this sensational event in the history of civilization :

" That morning I took it over to New York and walked into the office of *The Scientific American,* went up to Mr Beach's desk, and said I had something to show him. He asked what it was. I told him I had a machine that would record and reproduce the human voice. I opened the package, set up the machine and recited, ' Mary had a little lamb,' etc. Then I reproduced it so that it could be heard all over the room. They kept me at it until the crowd got so

great Mr Beach was afraid the floor would collapse; and we were compelled to stop. The papers next morning contained columns. None of the writers seemed to understand how it was done. I tried to explain, it was so very simple, but the results were so surprising they made up their minds probably that they never would understand it—and they didn't.

"I started immediately making several larger and better machines, which I exhibited at Menlo Park to crowds. The Pennsylvania Railroad ran special trains. Washington people telegraphed me to come on. I took a phonograph to Washington and exhibited it there. . . . Members of Congress and notable people of that city came all day long until late in the evening. I made one break. I recited 'Mary,' etc., and another ditty:

> "There was a little girl, who had a little curl
> Right in the middle of her forehead;
> And when she was good she was very, very good,
> But when she was bad she was horrid.

"It will be remembered that Senator Roscoe Conkling, then very prominent, had a curl of hair on his forehead; and all the caricaturists developed it abnormally. He

was very sensitive about the subject. When he came in he was introduced; but, being rather deaf, I didn't catch his name, but sat down and started the curl ditty. Everybody tittered, and I was told that Mr Conkling was displeased. About eleven o'clock at night word was received from President Hayes that he would be very much pleased if I would come up to the White House. I was taken there, and found Mr Hayes and several others waiting. Among them I remember Carl Schurz, who was playing the piano when I entered the room. The exhibition continued till about 12.30 A.M., when Mrs Hayes and several other ladies, who had been induced to get up and dress, appeared. I left at 3.30 A.M.

"For a long time some people thought there was trickery. One morning at Menlo Park a gentleman came to the laboratory and asked to see the phonograph. It was Bishop Vincent. . . . I exhibited it, and then he asked if he could speak a few words. I put on a fresh foil and told him to go ahead. He commenced to recite Biblical names with immense rapidity. On reproducing it he said: 'I am satisfied now. There isn't a

man in the United States who could recite those names with the same rapidity.' " [1]

A company was immediately organized, which agreed to pay Edison a lump sum of ten thousand dollars, in addition to a royalty of twenty per cent. But the enterprise did not become a commercial success on a large scale until ten years later, when the inventor, after long absorption in his work upon electric lamps, again turned his attention to the phonograph, and succeeded, after various improvements, in making it more accurate and practical.

It was in 1888 that Edison resumed his work upon the phonograph. In the meantime, however, he had become perfectly aware of the instrument's defects. The problem was extremely delicate. A recording cylinder of wax had been substituted for the sheet of tinfoil, and the steel pencil was replaced by a little knife made of sapphire, whose function was to plough a channel in the wax, forming a spiral around the cylinder.

Edison was obliged to prolong and multiply his efforts before his phonograph was brought to the point of exactly imitating the human

[1] From Dyer and Martin's *Life of Edison.*

voice. It is told, for instance, that he spent month after month before his instrument, which proved to be a most backward pupil, had learned to utter a correct *s* or an intelligible *p*. The confounded machine obstinately persisted in speaking like a small child, and not at all like a well-educated person and an adult member of correct society.

But at last the improved phonograph, while not fully meeting his expectations, consented to make a certain appreciable progress. In 1888 a machine incorporating these first improvements was sent to the Crystal Palace in London. As in the case of the telephone, Colonel Gouraud undertook to obtain a public recognition befitting the importance of this new model, which was destined to be followed by a long succession of others. (For the list of patents granted by the Patent Office contains mention for the year 1888 alone of no less than thirty improvements connected with the phonograph.)

The success in England was immense. Colonel Gouraud issued invitations to his friends; for Edison had sent to him, as his representative in England, a phonogram

—that is to say, a letter recorded upon a wax cylinder. One of Edison's assistants in America, a most diligent workman, had formed the habit of communicating with his family by means of these phonograms. They would place the wax cylinders in the instrument, which would then promptly reproduce his words with more accuracy than the most faithful messenger could have done. In one of his phonograms he sent a message to his dog and even called it with his customary whistle. On hearing his master's voice, the faithful beast began to bark and to hunt everywhere for him, greatly surprised at not finding him after having heard the familiar call.

Colonel Gouraud's guests had the pleasure of hearing Edison read his own letter. Furthermore, he had taken advantage of the opportunity to express his thanks to the members of the London Press, who had devoted some highly eulogistic articles to him. Then followed a concert, in which not only the human voice, but the music of various instruments, ranging from the flute to the trombone, had their part. Many illustrious personages sent their congratulations to

Edison in the form of phonographic records. The enthusiasm was shared by Queen Victoria herself and her Court, as well as by some of the most famous English statesmen. The celebrated tragedian Henry Irving recited for the phonograph, and the instrument had the further distinction of recording for the benefit of posterity the voice of Cardinal Manning, of Tennyson, and of Browning. The last-named, when his memory failed him, while reciting one of his own poems, interrupted the harmonious flow of his verse with exclamations of annoyance.

Thanks to Edison's genius, these voices may still be heard in spite of the silence of the tomb. The King of Greece, when solicited in his turn, expressed regrets similar to those that we ourselves just formulated, deploring the absence of the phonograph in the days of Homer.

Shortly afterward the Paris Exhibition of 1889 confirmed the triumph of Edison in Europe. Forty thousand persons a day flocked to become initiated into this great miracle. The scientific and social use of the phonograph was further demonstrated in a number of other ways. Savorgnan de Brazza

was present at the Exposition with a number of negroes belonging to various African tribes. They consented to talk into the phonograph, and it was then realized how valuable the instrument might become for the comparative study of these little-known dialects.

A Sioux chief belonging to Buffalo Bill's Wild West Show was terror-stricken when he heard his own voice reproduced with such exactness, and insisted that it was due to the intervention of the Great Spirit.

When perfected, the new phonograph became what it had not previously been, an article of commerce. The first company which attempted to put the machine on the market ended in disaster. Edison took up the enterprise on his own account and founded the National Phonograph Company. From that time forward the industrial and commercial success was complete, since from the date of the reorganization the company has sold over a million and a half phonographs. At the present time the annual sales amount to about £70,000, including the cylinders and other supplementary apparatus.

Without wishing to detract in any way from Edison's glory as an inventor, it is at

least curious to note that the creator of the phonograph had two predecessors in France, as little appreciated during their lives as after their death. The first of these was Scott de Martinville, the second was Charles Cros.

Édouard-Léon Scott de Martinville, born at Paris in 1817, was a descendant of a Scotch family which had settled in Brittany. He entered the Didot printing house, familiarized himself with works of science, and, having asked himself whether it would not be possible to do for vibrations of sound what Daguerre had already done for light, invented a *phonautograph*. Pouillet was informed of this invention, in which, as M. Siry has set forth in an interesting notice, application was made of natural acoustic means for obtaining a graphic record of the voice, of music, and of any kind of sound.

Pouillet raised the sum needed to cover the expense of the first annual payment for a patent-right. Thereafter a manufacturer of acoustic instruments, Koenig by name, also interested himself in the discovery made by this journeyman printer. And, at a congress held in Aberdeen, the Abbé Moigne demonstrated that the solution of the

problem of the automatic recording of sounds had been found.

In 1857 Scott had deposited a sealed communication with the secretary of the French Academy of Sciences. It was opened 15th July, 1861, and was entitled "The Principles of Phonautography."

What Scott had written ran in part as follows:

"Is it possible to obtain, in regard to sound, a result analogous to what is being done to-day in regard to light, by means of photography? May we hope that the day is near at hand when a musical phrase, emanating from the lips of a singer, will record itself of its own accord and without the musician's knowledge upon an obedient sheet of paper, leaving an imperishable record of those fugitive melodies, for which memory might afterward have searched in vain? Will it be possible to place between two men, brought together in a silent chamber, an automatic stenographer, which will preserve the interview down to the most minute details, adapting itself at the same time to the speed of the conversation? Will it be possible to preserve for the benefit of future

generations some records of the manner of speech of certain of our eminent men, our great actors, who die without leaving behind them the faintest trace of their genius ?

" It is my belief that the principle has been found. There remain only the difficulties of its application, great, no doubt, but not insurmountable, thanks to the present state of physical and mechanical arts."

Here followed a theoretical exposition of Scott's discovery and a description of his apparatus consisting of four principal parts :

1. An acoustic shell, designed to collect and condense the vibrations.

2. A tympanum or inner drum of gold-beater's skin, besides an external membrane, the tension or relaxation of the membranes being controlled by two rings.

3. An index-point for tracing the record.

4. A glass table moving according to certain laws and coated above with lamp-black and below with paper covered with a scale of millimetric divisions.

The scientific societies, impressed chiefly with its errors and imperfections, gave Scott's invention a rather ironical reception. At the time of a conference on acoustics, held in

1860, Scott's phonautograph was seen in operation, and recorded the sounds of two organ-pipes connected with a single bellows, at a distance of about three feet from the sound receiver.

Lack of influence, and more especially of money, prevented Scott from perfecting his phonautograph. But it seemed necessary here, while rendering to Cæsar the things that are Cæsar's, to pay a sincere tribute also to the obscure, but none the less remarkable, efforts of Édouard-Léon Scott de Martinville.

As a matter of fairness, we ought also to make brief mention of a compatriot of Scott's, the poet and imaginative writer, Charles Cros, who in a communication deposited with the Academy of Sciences, 3rd April, 1887, described the main principles of an instrument for the reproduction of speech by means of tracings recorded on a prepared disk.

"My invention," wrote Charles Cros, who, as this goes to prove, was something more than the picturesque author of the *Coffret de Santal* and *Hareng Saur*, "consists in the main of a process for obtaining a tracing of the movements of a vibrating membrane, and afterward using this tracing for the

purpose of reproducing the same vibrations with their intrinsic relations of duration and intensity, either by means of the same membrane or some other one equally adapted to reproduce the sounds and noises resulting from this series of movements.

"Accordingly, the whole problem is to transform an extremely delicate tracing such as can be obtained with the lightest sort of an index point grazing a surface coated with lampblack—to transform such a tracing, I say, into reliefs or indentations sufficiently rigid to serve as a guide for a flexible spring that will communicate its movements to a sonorous membrane.

"A light index is attached to the centre of the surface of the vibrating membrane and terminates in a point (a metallic wire, a pen-point, or the like) which rests upon a glass plate blackened by a flame. This plate is attached to a disk capable of the double movement of rotation and rectilinear progression. If the membrane is in a state of rest, the point will trace a simple spiral; if the membrane is vibrating, the spiral traced by the index point will undulate, and its undulations will exactly represent all the

vibrations of the membrane, with their relative duration and intensity.

"This undulating spiral, traced upon a transparent plate, must now be reproduced, by means of photographic processes, such as are at present quite familiar, by a line of similar dimensions traced in a series of indentations or raised points, on some rigid material, such, for example, as tempered steel.

"When this has been done, the rigid record is placed in the machine, which sets it turning and moving forward with the same speed and movement as that previously given to the recording surface. A metallic point, in case the tracing is a furrow, or a notched index, if the tracing is in relief, is held by a spring against the tracing, while the opposite end of the rod which holds this point or notch is fastened to the middle of the membrane designed to reproduce the sounds. Under these conditions the membrane will be set in motion, not by the vibrations of the air, but by the tracing which controls the pointed or notched index, receiving impulses exactly similar in duration and intensity to those which the recording membrane previously received.

"This special tracing represents successive and equal periods of time, while its length slightly increases at each revolution. This does not present any difficulties if only the portion near the margin of the revolving disk is used, since the turns of the spiral are very close together; but, on the other hand, the central surface is lost.

"In any case, a spiral tracing around a cylinder is preferable, and I am at present endeavouring to find a practical application of it."

There seems to have been good reason for M. Siry to cite Charles Cros, as well as Scott, as a precursor of Edison. Cros never had sufficient material resources to achieve a successful result for his enterprise. And in the end this ingenious discoverer fell a victim to the hardships of life. It is known—or rather, hardly any one knows—that he also advanced some very definite ideas regarding colour photography. In 1877, only a few months before Edison's discovery, the Abbé Leblanc called attention to Charles Cros's discovery in the following terms, the importance of which cannot fail to be recognized:

"It is no longer a question of simple

transmission of sounds, as in the case of the telephone, at the moment when they are produced; it is a question of no less a miracle than that of recording and storing up sounds and reproducing them at will to an unlimited extent. Thus, if you take M. Cros's invention and sing into it, let us say, a little song or make a speech, the instrument which has received and, as it were, taken down in shorthand your words, your song, your music, retains a record which may be transferred to metal by the electroplating process, and which, when set in motion, will reproduce your voice, your articulation, your very tone, in short, the speech that you delivered or the song that you sang exactly as though you yourself were repeating the one or the other in your natural voice.

"By means of this instrument which, if we were called upon to serve as godfather, we should christen *phonograph*, it will be possible to take photographs of the voice as we now take them of the face; and these photographs, which ought to receive the name of *phonograms*, will enable us to hear men and women speak and sing and declaim centuries after they have passed away, precisely as

they spoke and sang and declaimed while they were alive. Undoubtedly the phonograph will never be used to reproduce all the declamations and conversations and songs of any human being throughout his life; but it will reproduce such portions of his discourse, songs, and other sounds as he has chosen to record. The records thus made will be preserved as specimens.

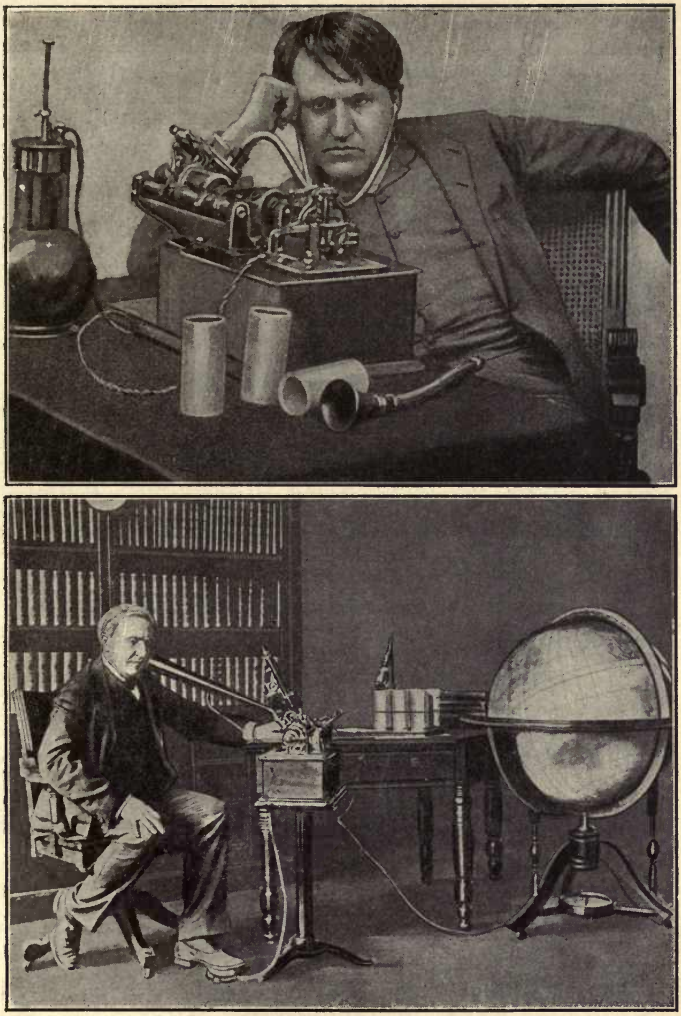
"Will that not be one of the most curious things that can possibly be imagined? To sit for a while and listen, for example, to the singing of some song which has rendered such-and-such a singer famous, and to hear this song rendered with the same identical voice by a simple physical instrument named the phonograph, which mechanically makes use of a plate made for the purpose and which can be preserved for ever, just as the plates of wood or steel engraving can be preserved?"

Was not this clear and was it not really prophetic? And was it not quite legitimate that we should remember to make mention of Scott and Charles Cros in this connexion?

Edison is extraordinary in his ability to achieve his fundamental ideas and day by day to render them more complete and better

adapted to our desires and our needs. And he is no less astonishing for his gift of extracting from his inventions a host of other inventions of all sorts, every one of which possesses its own special interest and bears the imprint of his mind, and of his unique and unsurpassed ingenuity. In this way, for example, among other masterpieces born of the union of electricity and mechanics, we have the telephonograph, which is a combination of the phonograph and the telephone. It was tried experimentally between New York and Philadelphia for the first time in February 1889.

We may cite further the megaphone and the aerophone. The megaphone serves to make sounds audible when they come from a long distance and consequently have lost their intensity. It consists of two huge acoustic tubes or horns about six feet long and tapering from a diameter of two and one half feet to a small aperture provided with ear-tubes, and they are mounted on a tripod of about the height of a man. Thanks to this apparatus, and in spite of its simplicity, it is possible to carry on a conversation at a distance of more than two miles.



EDISON AND THE PHONOGRAPH

*Above:* Edison at his Phonograph, after several days and nights of toil.
*Below:* Edison engaged in perfecting his Phonograph.

The purpose of the aerophone is to amplify sound. It consists of a diaphragm whose vibrations serve to open and close the valves of a huge steam whistle or organ pipe. By means of this apparatus the ordinary sound of the voice is magnified two-hundredfold. In this manner the astute Wizard of Menlo Park, who is before all else a calm and unemotional scientist, has succeeded in transforming the human voice into a terrible voice, the voice of a giant, and in this way he has once again introduced an element of dreams and nightmares into the realities of life.

But without attempting to draw up even an approximate list of all of Edison's inventions pertaining to the phonograph, it will suffice if we merely point out that a good many of them very pleasantly combine utility and entertainment. In his spare moments the great American sorcerer amuses himself with this odd and surprising type of creation. He is the first to laugh over them, and they serve to divert his friends.

It is told, for instance, that one night one of his guests, comfortably installed in a large, well-ventilated bedroom, was suddenly

awakened by a deep, grave voice pronouncing the following words:

"Midnight has struck; prepare to meet your God!"

But a few moments later the same voice added: "Don't be frightened, old man, it is only the clock!"

Edison, however, had it in his power to give his guests an emotion of quite a different sort and of a far higher order. He had asked his friend, Colonel Gouraud, to send him a record of Gladstone's far-famed voice. One evening, after Gladstone had listened, thanks to the phonograph, to "Israel in Egypt" exactly as it was given at the Händel Festival in 1888—that is to say, with a full orchestra, a chorus of four thousand voices and an immense organ—he sent his thanks to Edison in the following terms, recorded by Mr Mundel and reproduced by the obedient machine:

"I am profoundly grateful to you, not only for a highly artistic entertainment, but for an initiation into the possibilities of a scientific marvel which has given me one of the most delightful evenings of my life. Yours is the nation which shows us the road to discoveries. And it is with all my heart that I take the

liberty of offering you, who are one of America's greatest glories, my warmest congratulations and sincerest good wishes. May you long be spared to continue your work for your country's higher honour and the greater good of humanity."

---

March 22 1892.

Monsieur.

I take pleasure in sending you one of my photographs for publication

Yours Very Truly

Thomas A Edison

EDISON'S HANDWRITING

## CHAPTER VI

### LET THERE BE LIGHT! AND THERE WAS LIGHT! AND THIS LIGHT EMANATED FROM AMERICA

WHEN Edison is asked which among all his inventions—and they are so many that it is almost impossible to enumerate them—is the one that he prefers, he answers readily: "My lamp and my system of lighting."

The incandescent electric lamp, invented by Edison, continued in use for a period of twenty years. In this order of ideas he was and still remains the great inventive genius; it was he who conceived the modern method of lighting.

We can no longer imagine what life and civilization would be without electricity and without electric light. Nevertheless our parents contented themselves with the more modest gas jet. We, having become more pretentious, demand that we shall see as well at night as in the day, and even better.

At the outset of the nineteenth century it had begun to be asked whether a substitute could not be found for the kerosene lamp and the tallow candle. The first gas company was organized in London in 1804. Davy and Watt called the attention of the public to the necessity of improvements in lighting. In 1866 the discovery of the dynamo made it possible to transform the energy of steam engines and turbine wheels into electric current. In this manner a source of electric power was obtained at moderate cost. How was this power to be employed for the purpose of lighting?

In order to place the problem clearly before us, we need only call to mind the fact that there were two methods by which the properties of the electric current could be used to this end. It was possible either to take advantage of Davy's discovery and utilize the arc light obtained by passing a powerful electric current between two carbon points; or else to follow Grove's method for little incandescent lamps (1840), by passing the electric current through conductors formed of exceedingly fine filaments.

But a thousand technical difficulties were encountered.

In Germany the city streets were lighted by means of arc lamps. But this form of light was not adapted for small, enclosed spaces. In England and America attempts were being made to perfect the incandescent lamp on account of its moderate cost and numerous other advantages. The stumbling-block, in the first type of lamp, was the burning out of the carbon, and, in the second type, the burning out of the filaments, whether of carbon or of metal. How was an incandescent lamp adapted to practical purposes to be obtained ?

And this question necessarily included a second question : How was a complete system of electric lighting to be created capable of taking the place of gas by combining all the advantages of gas with those offered by electricity ?

In 1877, in the full height of his powers, Edison, without losing sight of his talking machine, turned his attention to the incandescent lamp. He began his experiment with filaments of platinum, then substituted carbon, then returned to platinum, and then once again to carbon.

Day after day and night after night, with a

dogged determination that before long had involved an expense of more than forty thousand dollars, Edison devoted himself to the solution of this problem. It seemed to depend upon just one little detail; but he foresaw—and before long all America foresaw with him—that the results would be most impressive. Yet there were other able scientists who were working toward the same goal.

A sort of feverish expectancy had been awakened within the best-informed circles; they put their trust in Edison, in spite of the doubts and the incredulous smiles of many theorists; and in 1878, notwithstanding that his lamp was very far from giving him satisfaction, a number of financiers came together and formed a company. They placed enormous sums at the inventor's disposal. The shares in the company rose in value and became one of the best investments in the New York Market.

From that time onward a formidable activity reigned throughout the laboratories of Menlo Park. To manufacture filaments, to raise them to the point of incandescence, and to note the length of their endurance, was now the whole object of the investigation

conducted by Edison and his assistants. All the resources of the intelligence and will-power of this Titan of modern science and civilization were consecrated to the creation of a lamp that would consent to burn for forty-eight hours.

Little by little he had acquired the conviction that the fibres of plants were the only substance that would offer sufficient resistance. After long research he came down to employing a filament of cotton. His achievement, in collaboration with Batchelor, from the 18th to the 21st of October, 1879, deserves to be related at full length upon the honour page of the golden book of modern invention, on which is proclaimed the patient energy of the modern scientist who, through his struggle with the elements of nature, is destined by aid of new combinations to enrich the patrimony of civilization.

Beginning on the 18th, Edison and Batchelor succeeded in carbonizing a filament of cotton. Their delight may be imagined. But when they attempted to test it by connecting it with the electric current, it broke.

This did not disturb the experimenters, whose business it is to expect all sorts of

mishaps, even the most deplorable, and to remedy them forthwith. On the contrary, this set-back stimulated their intrepidity. The goal was near at hand. They swore that they would not sleep again until they had conquered the hostility of inanimate things. By the 20th of the month they had succeeded in making a second filament of carbonized cotton. Picture their anxiety when they undertook to attach it to the conducting wire! And their joy when they succeeded!

Unfortunately, when poor Batchelor crossed the hall for the purpose of protecting their product with a glass bulb, there came a breath of wind and there the filament was, broken like its predecessor. Conscience-stricken, he returned to Edison, who, unperturbed, began the task over again.

On the 21st of October the lamp, the famous lamp, was an accomplished fact. It was placed under observation before the vigilant eyes of a number of engineers. And while the good news was being flashed throughout the length and breadth of the United States, Edison was still sleeping a well-earned sleep.

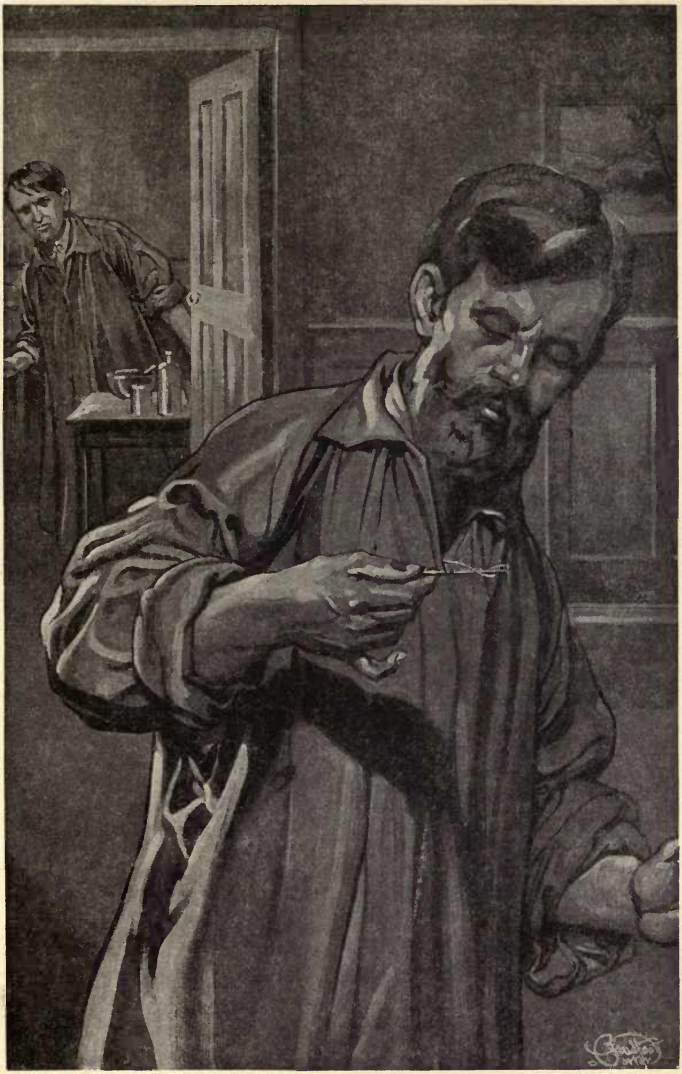
When he awoke the lamp was still burning,

and it continued to burn for more than forty-eight hours. The filament had shown an excellent resistance to the heat.

By producing a more perfect vacuum in the bulb, a greater length of endurance was obtained. At the same time the search was continued for some better method of producing filaments.

The public hailed with delight this new and dazzling manifestation without, however, even beginning to realize the prodigious qualities of Edison's inventive genius. It was easy enough, without such realization, to admire the daylight brilliance of the seven hundred lamps installed in the laboratory and various other buildings and workrooms of Menlo Park. This demonstration was certainly as decisive as it was impressive. It became necessary to revise the schedule of railway trains, in order to give every one a chance, engineers, scientists, business men, and simple sightseers, to marvel over the Edison lighting system.

Straightway the shares of the Edison Company soared from $106 to $3000. Within the year and with equal success an electric lighting plant of one hundred and twenty



"THERE CAME A BREATH OF WIND AND THERE THE FILAMENT WAS, BROKEN LIKE ITS PREDECESSOR"

lamps was installed on board the steamship *Colombia*.

Edison, however, was not satisfied with these achievements. He established a manufactory of lamps, the first of its kind. Still engrossed with the idea of perfecting an instrument that was destined to play so important a *rôle* throughout all civilized nations, he abandoned the cotton filament in favour of one obtained from bamboo. The latter, when carbonized, exhibited remarkable elasticity and resistance. Thanks to such improvements and to various other modifications of detail, the inventor succeeded in producing an incandescent lamp which would last from a thousand to fifteen hundred hours.

The Edison lamps, exhibited at the Paris Electrical Exposition of 1881, came as a revelation, no less to the specialists than to the general public, of a new and imposing order of things. In Edison's exhibit it was possible to follow all the phases of manufacture, from the first treatment of the raw materials down to the final achievement of incandescence. It was a spectacle as instructive as it was picturesque, and it

produced a sensation throughout all Paris. It has been said, with good reason, that Paris is the City of Light. At that period Paris was the City of Edison Light.

Consequently the inventor was well repaid for having sought this second recognition of his great and superb accomplishment. His lighting system was hailed with veritable transport. Five gold medals and a diploma of honour were awarded him; and the telegram announcing this award said further: "Complete success. The committee had nothing more at its disposal to give you." And his success was no less marked at subsequent expositions; it was quite as notable at Philadelphia in 1884 as at Munich in 1882 and at Vienna in 1883.

According to his custom, Edison now proceeded to busy himself with the commercial extension befitting a business opportunity of such magnitude. And, as a matter of fact, it was a colossal, world-wide opportunity.

Electric lighting plants in which Edison had an interest began to multiply first of all in America. Then in all the capitals of Europe Edison companies were founded: in London, in Paris, and in Berlin, where the

Allgemeine Electricität-Gesellschaft became the most extensive of any in the world.

By 1891 more than 1,300,000 Edison lamps proclaimed his glory and universal sovereignty. Meanwhile he had continued his experiments indefatigably, and had replaced the bamboo filament by other materials, among them by a substance obtained from cellulose.

In the sciences and industries there is a ceaseless evolution. Edison's creation, transformed and adapted to every need, surpassed itself. He had opened an immense, an infinite field, into which other gifted inventors might follow him, to their greater glory and profit.

In the case of the incandescent lamp, just as in that of his other inventions, Edison was obliged to scatter gold with a free hand, and the outlay may be estimated at upward of twenty thousand pounds. Wishing to obtain a peculiar species of bamboo, which he deemed essential to the success of his incandescent lamp, he began by sending Mr William H. Moore to China and Japan. This adroit emissary and able diplomat left New York in the summer of 1880, and forwarded to Menlo Park various specimens of bamboo. Furthermore, he made arrangements with a

Japanese farmer for a continuous supply of certain species. Edison still remained dissatisfied with the results. In December 1880 Mr Brauner set forth in his turn. But the bamboos which he found in the southern regions of Brazil were judged to be no better than those of Japan. Accordingly a small expedition was next organized for the purpose of ransacking Cuba and Jamaica, in quest of this same famous and ideal bamboo. But this also proved to be in vain.

In 1887, with his extraordinary and indefatigable persistence, and remembering, perhaps, a description given by Humboldt of a bamboo growing on the banks of the Amazon, Edison commissioned Messrs McGowan and Hanington to undertake an exploring trip in South America.

McGowan made his way up the Amazon River, sometimes on foot, sometimes in a canoe, constantly in the face of great danger. His adventures were most dramatic, and his end was no less so, because after having returned home, bringing with him some very curious specimens of bamboo, he subsequently disappeared, without it ever being known what became of him.

The public Press published dithyrambic articles upon his fifteen months' explorations, through districts infested with fevers, Indians, and snakes. He passed a hundred and ninety of these days almost without food, and a hundred without change of clothing. It was a singular destiny to have escaped so many perils, only to meet a mysterious fate in the very heart of American civilization!

Here, for example, is what *The New York Evening Sun* said, in the course of a sensational interview with McGowan:

"In pursuit of a substance that should meet the requirements of the Edison incandescent lamp, Mr McGowan penetrated the wilderness of the Amazon, and for a year defied its fevers, beasts, reptiles, and deadly insects in his quest of a material so precious that jealous Nature has hidden it in her most secret fastnesses.

"No hero of mythology or fable ever dared such dragons to rescue some captive goddess as did this dauntless champion of civilization. Theseus, or Siegfried, or any knight of the fairy books, might envy the victories of Edison's irresistible lieutenant.

"As a sample story of adventure, Mr

McGowan's narrative is a marvel fit to be classed with the historic journeyings of the greatest travellers. But it gains immensely in interest when we consider that it succeeded in its scientific purpose. The mysterious bamboo was discovered, and large quantities of it were procured and brought to the Wizard's laboratory, there to suffer another wondrous change and then to light up our pleasure haunts and our homes with a gentle radiance."

Even after making allowance for the element of exaggeration which is inherent in all newspaper accounts, and especially in American newspapers, it is nevertheless true that there is something marvellous and epic in all that relates, either from near or far, to Edison.

Mr James Ricalton was still another of his emissaries. He was principal of a school at Maplewood, New Jersey, and was known for his researches in natural history. The account of his first interview with the famous inventor is quite characteristic. Edison said to him:

"I want a man to ransack all the tropical jungles of the East to find a better fibre for my lamp; I expect it to be found in the palm

or bamboo family. How would you like that job ? "

Mr Ricalton replied :

" That would suit me."

Then ensued the following brief dialogue :

" Can you go to-morrow ? "

" Certainly, but I must arrange for a substitute. Can you tell me how long the trip will take ? "

" How can I tell ? Maybe six months and maybe five years ; no matter how long, find it."

This interview is equalled only by that which took place more than a year later between the same two persons. Mr Ricalton had returned from India and Ceylon, where he had discovered that even the humblest of donkey-drivers were familiar with the name of Edison. He brought back to Menlo Park upward of one hundred species of bamboo, which he had collected under great difficulties ; two of them gave more satisfactory results than any of the others. At this period, however, Edison was striving to perfect a filament of artificial carbon which promised to prove far superior to bamboo.

Discovering the presence of Mr Ricalton,

he advanced to meet him, shook hands, and asked:

"Did you find it?"

"Yes," answered the returned traveller.

And the inventor passed on, troubling himself no further about a great expense and a great effort which had proved futile.

As early as 1881 Edison had exhibited, at the Paris Electrical Exposition, a huge steam dynamo of twenty-seven tons, of which the armature alone weighed six. From the outset of his work upon the incandescent lamp he had concerned himself with the problem relating to currents of great intensity and to machines capable of producing these strong currents. His discoveries and inventions pertaining to the utilization of electrical power were supplemented and perfected by those of the Hopkinson brothers.

It was not long before Edison built a machine of 140 horse-power, generating a sufficient current to supply 1300 lamps, and in which 90 per cent. of the mechanical energy was transformed into electrical energy. Here again the great American engineer showed the way along which the technicians of the Old and the New World alike must follow

him, sustained by his example and glorious initiative.

The installation of this kind of power house for the supply of electrical power was at that time an entirely new thing. Edison was obliged to redouble his activity and give unremitting attention to the New York power houses which had invited his co-operation.

Experience on all points was lacking. Edison, who had made the plans for the tube-conductors, did not disdain, as the phrase goes, to put his hand to the plough and work personally, like any journeyman, at the task of laying the underground wires.

Little by little Edison's earlier ideas regarding the sale and utilization of electricity became amplified. It proved, indeed, to be not merely a matter of using the current for public and private lighting, but also for electric motors and arc lights. He took out numerous patents relating to these instruments, as well as to accumulators for the storage of electric energy.

In these various applications of his system he gave proof of a more and more surprising ingenuity, both in certain details regarding

the placement of the dynamos and in the measurement of the currents. His electrolytic meter and his various apparatus designed for measuring the quantity of amperes and volts bear overwhelming testimony to this.

In the same connexion, and with the same fertility of resources, he asked himself the same questions that he had previously asked in relation to telegraphy, and arrived at analogous practical solutions.

Thus, with his extraordinary aptitude for utilizing certain given elements and obliging them to furnish a maximum of return, he contributed toward the extension of the field of action of electric power plants. This result he achieved, not by multiplying the number of dynamos or increasing the diameter of the wires, but by a system of division of currents.

This electric power, which he succeeded in distributing so widely, was destined to be applied to an ever-increasing extent to our daily needs. Electricity furnished a motor power. The problem of electrical locomotion was squarely raised.

By way of experiment, Edison hastened to

construct an electric railway at Menlo Park, and after various accidents due to defects in the methods of construction, he finally succeeded in overcoming all difficulties by means of his series of resistance-boxes.

The Electric Railway Company was founded in 1883. There is no need to dwell here upon the vast development which this means of locomotion has undergone in all parts of the world. But it is worth while to call to mind the new *tour de force* accomplished by Edison, after the organization of this company.

It was decided to make a public demonstration of the advantages of the electric railway. A first-class opportunity occurred for making such a demonstration in a practical and decisive way. In spite of all sorts of difficulties, Edison succeeded, in a surprisingly short time, in constructing one-third of a mile of electric railway and putting it into operation, at the Chicago Railway Exposition. It continued in operation for thirteen days, during which time it carried no less than twenty-eight thousand passengers.

America to-day owes to this same great inventor her superiority in electrical trans-

portation and the construction of all the various machinery relating to it.

But electricity was capable of other things besides competing with other methods of locomotion; she was destined to afford a driving power for the various forms of mechanical work. This, indeed, was one of the vastest of all the problems which haunted the brain of this modern wizard, for ever labouring to revolutionize society through the transforming power of science and industry.

In default of natural electric power, steam-engines are employed to transform the solar heat stored up in coal into mechanical energy, in the form of electricity. Now, even under favourable conditions, 90 per cent. of the energy contained in the coal is lost. To avoid this loss would in itself amount to a revolution in our economic and social conditions.

Edison had pondered a great deal over this problem, seeking to develop the electric current directly from the coal, so as to do away with boilers and everything connected with steam-driven machinery. He sought to solve this problem by constructing a machine

operated by a pyromagnetic motor. These two inventions depend upon the principle that iron loses its magnetic properties through the application of heat.

But while awaiting those better days when nature will no longer succeed in keeping concealed from us any of those forces which we would be glad to turn to our advantage, Edison applied his processes to metallurgy, and by means of his electro-magnetic separator for iron ore opened up still another avenue for industry.

The separation of iron ore from the elements with which it is associated is not by any means one of the least interesting of Edison's discoveries. The story is told that one day, when passing along a wharf, he saw a pile of black sand. With his habitual curiosity, he promptly put some specimens of this sand in his pockets. On returning to his laboratory he put the sand on his table; at this moment a workman entered, stumbled, and, striking against the table, let fall a large magnet which he was carrying in his hand; the magnet dropped upon the little pile of sand, and when it was picked up Edison observed that it was covered with tiny black

grains, and consequently that the sand must contain iron. Immediately his inventive mind conceived the idea of extracting iron from even the lowest grades of ore by means of magnetic attraction.

Edison decided to put his electric separator into operation on a commercial scale. He built enormous machines, and, with his usual habit of doing everything on a huge scale, acquired a tract of land on which building after building was erected until the result was a veritable little village, which was christened Edison. The inventor and his associates lost, in the course of this experiment, a great deal of time as well as money. He was forced to abandon the enterprise, and he did so quite serenely, in spite of his enormous losses, for, while he regretted that he had spoiled a good business venture, he was happy in the knowledge of his discovery, and, confident in the future, scarcely gave himself time to regret it.

As he left this battlefield where he had for once been beaten, he merely frowned a little and contented himself with saying: "Well, the money is all gone, but we had a hell of a good time spending it!"

Is there not something quite admirable in this phrase, when we remember that Edison had furnished the company engaged in this enterprise with almost all the money that he had derived from his previous labours and inventions? In this instance, we are no longer in the presence of a magician, a wizard, an amazing experimenter, a scientist unique of his kind, but one of the rarest and noblest of characters produced by humanity, victorious even in his defeats and sublime in his duel with the forces of implacable nature.

## CHAPTER VII

RECORDING THE GESTURE—IN FULL FAIRY-LAND—A FEW OTHER MARVELS, SMALL AND GREAT

AT Menlo Park, one day, a farmer came in and asked if I knew any way to kill potato bugs. He had twenty acres of potatoes, and the vines were being destroyed. I sent men out and culled two quarts of bugs, and tried every chemical I had to destroy them. Bisulphide of carbon was found to do it instantly. I got a drum and went over to the potato farm and sprinkled it on the vines with a pot. Every bug dropped dead. The next morning the farmer came in very excited and reported that the stuff had killed the vines as well. I had to pay $300 for not experimenting properly." [1]

We see from this anecdote, related by Edison himself, that he had good reason to become more circumspect toward visitors,

[1] From Dyer and Martin's *Life of Edison.*

and also that he delights in exercising his ingenuity according to the needs of the hour and in relation to the most diverse necessities.

A business man was complaining one day, in his presence, of the precious time that he lost at his office because of the volume of his correspondence.

"You really ought to invent something," he said, "to save me from this loss of time."

Shortly afterward Edison sent to this same harassed man of business his electric pen, which, by aid of a small motor and the rapid movement of a tiny plunger, the point of which is projected a bare hundredth of an inch at each vibration, forms letters composed of minute holes in the paper. It is quite easy thereafter to make manifold copies of such a letter by means of a roller and ink.

In the mimeograph, which serves the same purpose, the paper is pierced by means of a steel plate, whose surface is studded over with a multitude of tiny points, while the words are traced upon the paper with a pencil, also of steel.

Without stopping here to examine the many wonderful electrical contrivances invented by

Edison, and notably his accumulator, we gladly pass on to linger over another of his greatest wonders, another miracle of this amazing prestidigitator.

The triumph of the phonograph had encouraged Edison to do for the eyes what he had succeeded in doing for the ears. But it is only within the last fifteen years that he has slowly perfected, in his Orange workshops, an apparatus conceived as early as 1887. Here again the glorious inventor has proved worthy of himself. His science has succeeded in achieving the most intense and artistic reproductions, thanks to a series of extremely ingenious combinations. From day to day they adapt themselves better and better to the lofty conceptions of a physicist who is able to imprison light, just as he previously imprisoned sound, and to record and preserve, in a halo of radiance, plastic grace and beauty, as well as all the varying spectacles borrowed from nature, and from the life of individuals and of races.

After the discovery of instantaneous photography, due to the gelatine-bromide plate, which required an exposure of only a fraction of a second, attempts were

made to obtain a more exact reproduction of reality—that is to say, to photograph moving objects at intervals of fractions of a second.

Edison, king of electricity and of speed, naturally considered as coming within his province this delicate research, this complex problem which proved to be subdivided into many problems, the successive solution of which was necessary before a satisfactory result could be achieved.

He employed an adjustment which enabled him to expose the sensitized plate forty-six times to the second. In this way he obtained forty-six images to the second, or 2760 to the minute. He succeeded in projecting them upon a screen at the rate of 14,000 separate images to every five minutes.

Then came another question: it was necessary to group and arrange these images in their proper sequence in some sort of a carrier. Since the images were very small, they were seen at first through a powerful magnifying-glass, and then exhibited by the aid of a magic-lantern. Now, the difficulty which presented itself was to find some way of moving the plates fast enough to secure

images that would be instantaneous, successive and separate.

Edison, with characteristic patience, proceeded from the glass plate to the sheet of gelatine, rolled in the form of a long strip around a drum and from that to the celluloid film in an endless ribbon. He adjusted his play of light so as to be exactly timed with the unrolling of the film.

Eager, as always, to follow up his investigations as far as possible, he built a small theatre at Orange, which had black walls and was capable of revolving on its axis. The pieces to be taken by the cinematograph are enacted upon the stage, the actors being illuminated either by the direct rays of the sun or by magnesium lights. Every one knows that the cinematograph has become one of the favourite amusements of the crowd, which flocks to these exhibits. According to his habit, and exactly as in the case of his phonograph, Edison simultaneously kept in mind the entertainment of the spectacle and the utility of the invention for scientific and educational purposes.

Thus, for instance, he employed the cinematograph for the clear and precise study

of microscopic phenomena, by showing the forms and the movements of infusoria developing in a single drop of water, which was their world. These comedies and dramas of the infinitely small assume an importance of their own when it is made possible for any one and every one to become initiated into the profoundest mysteries of nature.

It is needless to dwell upon the medical interest of inventions of this kind which provide students with means of following the actions and movements of bacteria with as much ease as they might those of a chicken or a lap-dog.

After succeeding in reproducing, very nearly to his own satisfaction, the effects of sound and light, Edison could not have been expected to remain content with the silence of his motion pictures; besides, he was logically the one best fitted to preside over the union of the cinematograph with the phonograph, and the happy birth of the phono-cinematograph. In this completed system the words and necessary sounds accompany the movements, and the whole magical illusion is complete.

Edison had at once foreseen what interest

his new invention would have as a source of popular entertainment. Henceforward the most sumptuous opera, choruses, and ballets could be offered to the public for a few pence, placing within reach of the humblest an endless series of new pleasures, as well as a liberal education, clear, precise and diverting, of harmonious and radiant beauty.

Is not this steadfast and kindly desire to place his long and persevering efforts at the service of essentially humane causes one of Edison's best claims to fame? Is it not an enviable *rôle* to have strewn the world and brightened our fragile terrestrial life with so many pleasures unknown to our fathers?

Yet the great magician who gives us so many treats, who permits us to hear the voices of the dead, who has found means to unite the past with the present and the present with the future by his almost miraculous evocations, must not make us forget the erudite man of science wholly absorbed by his task. For it is above all the physicist and chemist, the great worker in the laboratory, whom we must see, first, last and always, in Edison.

At the same time, however, in pursuance of his principle never to abandon to others the commercial development of his processes, but always to seek for new sources of revenue to swell the fund needed for further inventions, Edison has built up quite an important business out of his Motion Pictures.

Besides the theatre in Orange, there are two Edison theatres, or "Pantomime Studios," in New York. The larger of these is a three-storey building, containing on the one hand offices, storerooms for costumes and scenery, and a library, and on the other hand a theatre. The ceiling and walls are of glass, the floor-space is sufficiently large to permit of six simultaneous rehearsals, with all the necessary stage-settings for the drama or comedy in course of enactment.

A very large stock company is employed at these two studios, including painters, photographers, actors, electricians, costumiers, and other specialists. After having proved satisfactory to a committee of competent judges, the films are placed on sale. In spite of the enormous competition, the affairs of the company appear to be most prosperous, and all the more so because the sale of all the

various apparatus needed for exhibiting the films goes to swell the receipts.

A number of skilled experimenters are working with unwearying persistence, on lines laid down by Edison, at various improvements of the cinematograph in all its various forms, which day by day are being rendered more complete, whether for the purpose of study and instruction or as machines adapted to the entertainment of the crowd.

Edison sometimes enjoys attending these public performances and criticizing them, while he dreams of a still greater degree of reality. But, instead of lingering longer over these dazzling marvels, we must pass on to cast a wondering eye at still other inventions of this unparalleled creator.

Nothing could be more striking than his method of construction which makes it possible to erect a ten-roomed house in four days. And at the same time this little miracle seems, after all, perfectly natural! A steel mould is set up, into which the concrete is poured and allowed to harden. The mould is removed, and an entire dwelling, foundations, walls, cellars, every detail down

to the smallest window, appears as if by enchantment.

But Edison's audacious initiative does not stop at that. He has perfected a method for converting stone into cement. The stone is blasted out and then removed by gigantic ninety-ton cranes, which lift up six-ton fragments of rock as easily as a child picks up a ball. Locomotives convey the rock to some distance, where it is broken up between enormous cylinders. When pulverized, it passes under a roller, where the mixture of limestone and cement rock is completed.

Without having the least intention of attempting to enumerate all of Edison's countless inventions, we may call to mind the fact that he was the author of the first fluoroscope, after the discovery of the X-rays. And without stopping to examine all his lamps, and all his phonographic apparatus, we may content ourselves with mentioning, in addition to his motors and magnetos and manifold telephones, his batteries and regulators, his pyromagnetic generator, his models for syrens and musical instruments, an audiphone for deafness, his odoroscope, his method for distilling liquids, etc.

As may easily be imagined, Edison has not failed to follow with intense interest the progress of aviation. At the request of James Gordon Bennett, he experimented with a number of motors designed to serve for the 'heavier than air' type of machine. He invented one motor, to be run with gun-cotton, but after an explosion he gave up this line of experiment, deciding to confine himself to tasks that made a more direct appeal to his activities.

At the time of his last visit to France Edison did not forget to express his admiration for the magnificent daring of the French aviators and for the remarkable success which has been made of the aeroplane industry in that country.

As the inventor of a storage battery which facilitates economical electric locomotion, under conditions hitherto regarded as impossible, Edison plays a leading *rôle* in the essentially modern and already extraordinarily developed industry of tramways and automobiles. What is not so generally known is that, although far from interested in engines of death, because he is opposed to war and its atrocities, he nevertheless conceived an

electric submarine torpedo, in collaboration with Mr W. S. Sims. Several models of this have been constructed. He also gave some useful advice during the Spanish-American War of 1898.

But that is not his province. He has given himself up entirely to those industries of peace which promote the well-being of civilized nations. And if we realize the peaceful revolution in our manners and customs which electricity has wrought in less than half a century, just as the steam-engine and the printing-press did at earlier epochs, we shall continue to place Edison in the foremost rank of those who are working for the establishment of a new social order based upon the revelations of modern science.

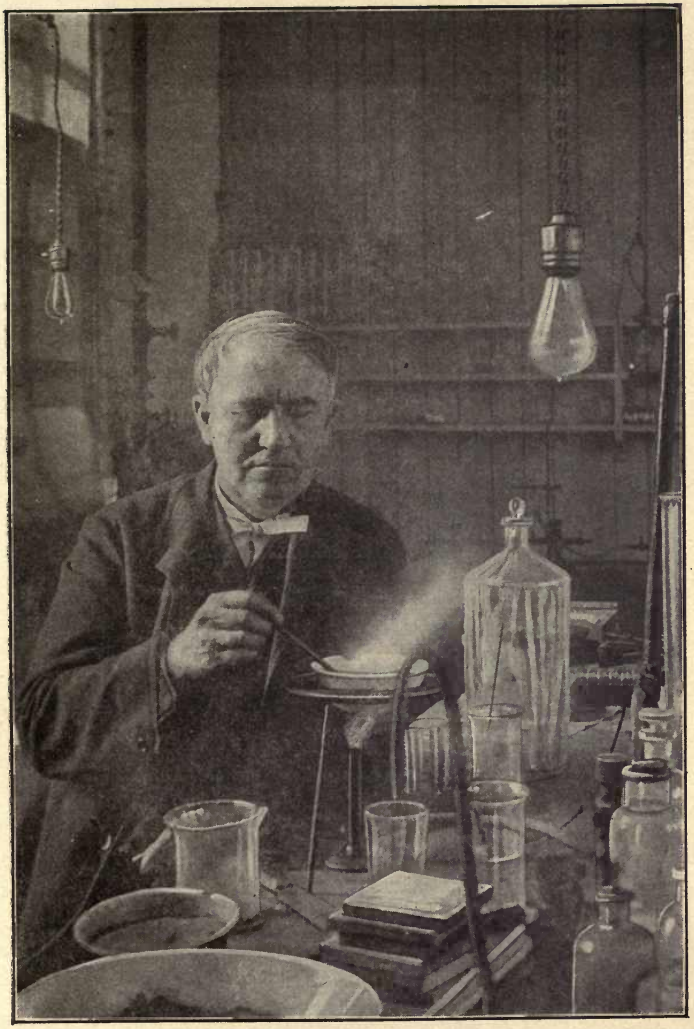
When the readers of *The New York Herald* were called upon to express their opinions, it was also in the foremost rank that they placed Edison, among the most distinguished personalities in America. And although inventors and business men have only too often found it to their interest to quarrel with him and to appropriate rights which the laws of the United States have not always adequately protected, no one is

under any misapprehension as to the quality of his genius.

And what if the world could know all his secrets! But he reveals them only one by one and at his own good pleasure. How many incomplete inventions, half realized in some corner of his laboratory at Orange, are destined to live only in the recesses of his brain!

Edison pursues his work without useless worry. He consoles himself for the brevity of existence by rendering his own as intense as possible. In many cases we may well regret that his industrial interests oblige him to fix his attention outside of his researches. But, besides the fact that his prodigious activity enables him to pass easily from one task to another as though he found the change restful, his chief strength lies in his ability to utilize the power of the dollar simultaneously with that of his daring thought and prolonged effort.

In order really to understand Edison, we must picture him in his coarse, chemical-spotted mechanic's garb, throwing a friendly, humorous word to the humblest man on the staff, rather than in an austere frock-coat more befitting a gentleman of professorial manner. There is no doubt about it. But



EDISON THE CHEMIST

The great Inventor has always had a marked predilection for chemistry.

at the same time we must never forget to see him from the standpoint of his practical Americanism, full of inexhaustible initiative. The king of electricity maintains his sovereignty only because he is also a monarch of commerce and industry.

It is impossible to calculate mathematically the commercial value of Edison's work. Nevertheless we may cite a few figures for the United States alone.

Central stations for the distribution of electricity: The capitalization is a billion dollars, the annual earnings two hundred and twenty-five million, the number of employees fifty thousand, the expenses forty million dollars. For the incandescent lamp the figures are: Capital, twenty-five million dollars; earnings, twenty million dollars; number of employees, fourteen thousand; expenses, eight million dollars.

In short, more than half a million workmen are employed for the exploitation of these great inventions of Edison's, which have transformed the world and have created one of the most formidable currents of social and industrial life that the history of civilization has had to record.

## CHAPTER VIII

MR EDISON DOES NOT RECEIVE—BUT HE WILL RECEIVE US—LLEWELYN PARK AT ORANGE, NEW JERSEY—THE RECIPE FOR GENIUS AND SUCCESS

IN his *Ève Future*, Villiers de l'Isle Adam, a poet of noble and picturesque verse, and of adventurous and at times bizarre imagination, shows us, in a fantastic tale, "not Mr Edison the engineer, but the magician of the century, the Wizard of Menlo Park, the father of the phonograph."

He compares the countenance of this man, who has made echo a prisoner, to that of Archimedes on a Syracusan medal. Here is the portrait which he has traced with no little art of that symbolic Edison of dreamland:

"He seemed lost in intense meditation. On his right, a high window, wide open to the west, let in the day upon the vast pandemonium, letting a haze of reddish-gold invade and overspread all objects. Here and there, encumbering the tables, appeared the faint

outlines of delicate measuring instruments, the wheels and gearings of unknown mechanisms, electric apparatus, telescopes, reflectors, enormous magnets, flasks filled with enigmatic substances, and blackboards completely covered over with equations."

What strikes us as curious in all this is the ease with which fantasy blends with reality, and hardly succeeds in surpassing it. Let us listen further to the following lamentations of Edison, recorded in a manner as strange as it is profound by this original writer of the decadent school :

" From among the noises of past ages, how many mysterious sounds were perceived by our predecessors which, through lack of any apparatus adapted to preserve them, have passed for ever into oblivion! Who, indeed, at the present day, can form any exact notion—for example, of the trumpets of Jericho, of the roar of the bull of Phalaris, of the laughter of the Augurs, of the sigh of Memnon before the dawn ? "

But we must not delay any longer over such purely imaginative fiction if we wish really to know and understand Edison, although in passing we may well recognize its

interest and the considerable truth which it contains in a general sense. The newspaper accounts which have appeared from time to time in both hemispheres, especially when copy was scarce, are hardly more exact. Edison, the most widely known man in the universe, is, as a matter of fact, for the most part greatly misunderstood. Let us add at once that it is a decided advantage to get a somewhat magnified view of him, if we wish to see him clearly. Accordingly, we should do wrong if we failed to recall the impression made by the most famous of modern enchanters upon the most celebrated enchantress of our own day.

"His marvellous blue eyes," writes Madame Sarah Bernhardt in her *Mémoires*, "more luminous than his own incandescent lamps, permitted me to read his every thought. . . . I followed him rapidly, climbing up stairs as straight and narrow as ladders, and crossing bridges suspended above veritable furnaces; and he explained everything to me as we went.

"I understood it all; and I admired him more and more, for he was both simple and charming, this King of the Realm of Light.

"While we leaned side by side over the fragile bridge that trembled above the frightful abyss in which immense wheels, carrying large driving belts, whirled and spun and roared, he gave various commands in a clear voice, and light burst forth on all sides, sometimes in crackling, greenish jets, sometimes in rapid flashes, and then again in serpentine trails like rivulets of fire.

". . . I looked at this man of medium height, with a head slightly too large and a profile full of nobility, and I thought of Napoleon I. There certainly is a strong physical resemblance between these two men, and I am sure that it is a case where the two brains would be found to be identical.

". . . The bewildering noise of the machinery, the blinding rapidity of the changing light, set my head to whirling; and, forgetting where I was, I leaned over the fragile railing which alone protected me from the depths below, with such complete unconsciousness of the danger that even before I had recovered from my surprise Edison had drawn me into an adjoining room and placed me in an easy-chair, without my having the slightest memory of his doing so. He told

me presently that I had had a slight touch of vertigo. . . .

"I was carried away by my admiration for this man's inventions. I was also charmed by his modest manner and gracious courtesy, as well as by his profound love for Shakespeare."

Following the example of Madame Sarah Bernhardt, let us also visit Edison—that is to say, let us visit simultaneously the inventor, the engineer and the Faust of modern times, who, in spite of his name and his fortune, is in reality a simple man, sincere and cordial, although terribly, even formidably, busy.

But who would not willingly pardon him for wishing to guard himself from importunate visitors? It is no more than right that his laboratory should be protected from inquisitive glances behind the shelter of high walls, and that the main entrance should bear the following notice: "On account of his work, Mr Edison finds it absolutely impossible to grant any personal interviews. No visitors will receive permission to enter here."

A general prohibition of this sort can always be excused in the case of an inventor,

and more particularly so in the case of Mr Edison. But since, in spite of our indiscretion, our intentions are honourable, we will take the liberty of disregarding the injunction.

We must not resent the attitude of the gatekeeper, a veritable Cerberus, who looks us up and down, and keeps us waiting until we have been identified beyond question. For is he not the self-same gatekeeper who subjected Mr Edison himself to a like examination and delay before he could be convinced that this clean-shaven personage with an energetic face was possessed of the proper credentials ?

Let us take advantage of this momentary delay to ask where we are. We have come to Orange, New Jersey. An electric tramway, a street car, whose economical motor, which makes it possible to cover a considerable distance without recharging the batteries, is another of Edison's inventions, has brought us to Llewelyn Park, the site of the Edison laboratory and of the residence in which he leads his peaceful family life.

We cannot help feeling a little surprised to think that all this power of human genius emanates from this tranquil and verdant

country district, in the midst of charming homes and wooded hill-sides.

It was in the year 1886 that Edison removed from his far-famed habitation at Menlo Park. He had need for vaster space, both for his own personal work and for the extensive manufactories of which he was to remain the head. He felt the need of a more scientific organization and system of management. After ten years of occupation and progress, Menlo Park had become obviously inadequate.

His ambition was to make this picturesque Orange valley the site of his manufactories and of a laboratory—the famous laboratory of his life-long dreams—that would be worthy to meet their requirements and augment their power. Consequently, Orange is not merely the home of the great inventor's laboratory, over which we are about to cast a glance; it it also a manufacturing centre, representing an invested capital of four million dollars and consisting of a whole group of enterprises, including: the Edison Manufacturing Company, the Bates Manufacturing Company, the Edison Storage Battery Company, the Edison Phonograph Works, the National Phono-

graph Company, and the Edison Phonograph Company.

But it is the scientist and the unsurpassed wizard whom we wish primarily to visit.

The laboratory, which has become, year by year, more spacious, more practical, more magnificently comfortable in the American sense, comprises one principal building—no sky-scraper, but a four-story structure, two hundred and fifty feet in length—and four one-story buildings, each one hundred and twenty-five feet long. We find ourselves first of all in the library, an almost square hall, whose dimensions are roughly a hundred feet by forty in height. Two galleries extend around the sides, and cabinets of various sizes contain superb collections of mineral and precious stones. The library itself comprises more than sixty thousand volumes ranged upon the shelves, not to speak of the scientific reviews, and all the technical publications in connexion with every art, science, and craft.

In this agreeably and harmoniously proportioned room we observe four electric chandeliers and a number of chairs and

tables. The boards of directors frequently hold their meetings around one of these tables. Edison presides over them with his clear, ardent, compelling, electric personality, communicating faith and energy to all his assistants.

Near to Edison's office, where he arrives punctually every morning, a sort of alcove has been contrived, which is furnished with a table and a chair. Here Edison takes his meals on the days when he cannot spare the time to return home.

Facing the principal entrance is a group acquired at the Exposition of 1889, a work by Bordiga, representing the triumph of electricity and electric light. On an adjacent table we perceive a pretty model in miniature of the poured-cement house invented by Edison. Portraits of scientists and celebrated men adorn the galleries. A bust of Humboldt and a statuette of Sandow especially attract our attention.

Adjoining the library is situated the celebrated stock-room, with its accumulation of the greatest variety of substances which the inventor may need to have immediately at hand. Sovereign experimenter that he is,

he must always take Nature as his starting-point and ceaselessly collaborate with her.

This stock-room contains an enormous collection, and at first sight a very strange one, including the simplest as well as the rarest elements of the animal, vegetable and mineral kingdoms. It ranges from teeth and horns to macaroni, oils and salts of every kind, and from every country, and even to pearls and diamonds.

Many a joke has been made at the expense of this stock-room, with its enormous assortment of substances. Mr T. A. Ebdell, the director of this department, has compiled two catalogues containing the lists of specimens. Side by side with silk and the barks of trees, mention is made of many deadly poisons, as well as of fish scales and camel's hair. M. Émile Durer, who has recorded some rather humorous memories of his visit to the laboratory at Orange, relates the following conversation with Mr Ebdell, its erudite and practical organizer. The latter had been boasting that he could satisfy, within a few moments, any need of the illustrious inventor. If he should send in a slip of paper demanding a plant growing thousands of miles from

Orange, a rose of Jericho, for instance, it would be sent to him within a few moments. If he should next require some ginseng, a precious plant which grows in China, and has the virtue of prolonging human life, it would be forthcoming.

"You see," concluded Mr Ebdell, "that I have everything that could be asked for."

"Really, you have everything?"

"Yes, everything. You can ask me for the rarest herb, the scarcest metal, and you shall have it in a moment."

"Very well, give me some paprika."

"I beg your pardon?"

"Paprika."

"You write it *pa-pri-cah*?"

"Not at all. The word is neither Japanese nor Chinese."

M. Durer found himself obliged to give a detailed explanation regarding Hungarian red pepper, alias paprika, and even to furnish an address from which it could be procured. And Mr Ebdell acknowledged that he did not possess quite everything, since this particular kind of pepper was lacking.

It would be possible to make quite a lengthy list of pleasantries of this kind, and

it is quite likely that there are still some gaps in the stock-room catalogue. But it is none the less true that Edison is able, in response to the inspiration, the happy hazard of the moment, to obtain any material whatever that he may need for his investigations. He can do this at any hour of the day or night, without appreciable delay.

We come next to the rooms devoted to machinery and mechanical experiments; they contain the models of various kinds of apparatus and of improvements connected with them. They occupy one half of the whole vast structure.

On the second story we come to the rooms set aside for experimenting. Let us stop in the X-ray room, and take a look, as we pass, at the machine which was forwarded to Buffalo at the time when Edison learned of the assassination of President McKinley.

Room No. 12 is of still more special interest, for it is Edison's own room. It contains every variety of apparatus that might be required successively by a physicist, a chemist, or a machinist, according to the needs of the day and the hour. Let us contemplate almost devoutly this place of retirement,

in which a human intellect of almost universal capacity wrestles with inorganic matter.

But at this point Mr Edison rejoins us in person, and we find ourselves in doubt as to which is the greater, our liking for him or our admiration. He smiles upon us with that charming good humour which at times expands into hearty merriment at the recital of some particularly amusing anecdote, some one of those occurrences which he delights in among his 'boys,' the devoted family circle of his assistants.

In physique Edison is tall, strong, and at the same time energetic and gentle. He looks exactly as he has been described, with a high forehead, frank blue eyes, a swift, clear glance, and a straight nose. His hair is quite grey. Yet he gives an impression of youth and health and strength. He leans toward us in order to hear us better, and because of his deafness holds his hand behind his ear. This deafness he has accepted with remarkable philosophy, and he freely declares that it has been a great advantage to him, particularly in connexion with his prolonged labours upon the telephone and phonograph,

because he found it impossible to satisfy himself, so long as the sounds were at all weak or indistinct.

We will continue on our tour of inspection. On the third floor we enter a hall which extends almost the entire length of the building; its walls are lined with cabinets containing all sorts of apparatus, motors, telegraph machines, phonographs, etc.

Above the library we pass through still other rooms devoted to experiments with the phonograph, also the private office in which the personal business affairs of Mr Edison are conducted under the direction of Mr H. F. Miller.

Since we have, unfortunately, no time for prolonging our sojourn at Orange, we must now leave this building, in which there are such a host of assiduous toilers, calm and yet at the same time feverishly active; for there are still four more buildings at which we must take a passing glance.

The first of these, known as the galvanometer room, was especially designed for the purpose of making electric measurements requiring the greatest precision and delicacy. Accordingly, in order to guard it from all

magnetic influence, iron and steel were both discarded in its construction. But after all these wise precautions had been taken an electric trolley line was installed directly beneath its windows! Consequently, all the instruments had to be relegated to a useless inactivity on walls, tables and shelves.

Without pausing at a small outhouse used by the inventor for his experiments in concrete houses, we enter the second of the four single-story structures. We soon perceive that it is an admirably equipped chemical laboratory. A large corps of experimenters are employed there, and Edison often joins them when some question arises which he wishes to solve by manipulations of special delicacy.

The third structure contains more apparatus and utensils, as well as models, while the fourth is a supplementary stock-room, besides containing photographic and cinematographic apparatus.

At Orange, just as formerly at Menlo Park, Edison is constantly besieged with more or less legitimate demands upon his time, and notwithstanding his courtesy, which turns to affability when he has to do with brother

scientists or artists or any one earnestly striving to make the most of his talent, he is often obliged to deny himself to visitors.

It sometimes happens also that he forgets them, just as he one day forgot a gentleman who had been delegated to present him with a medal that was a mark of very high distinction from some society, the name of which escapes our memory, and who waited for hours in the laboratory, and all in vain.

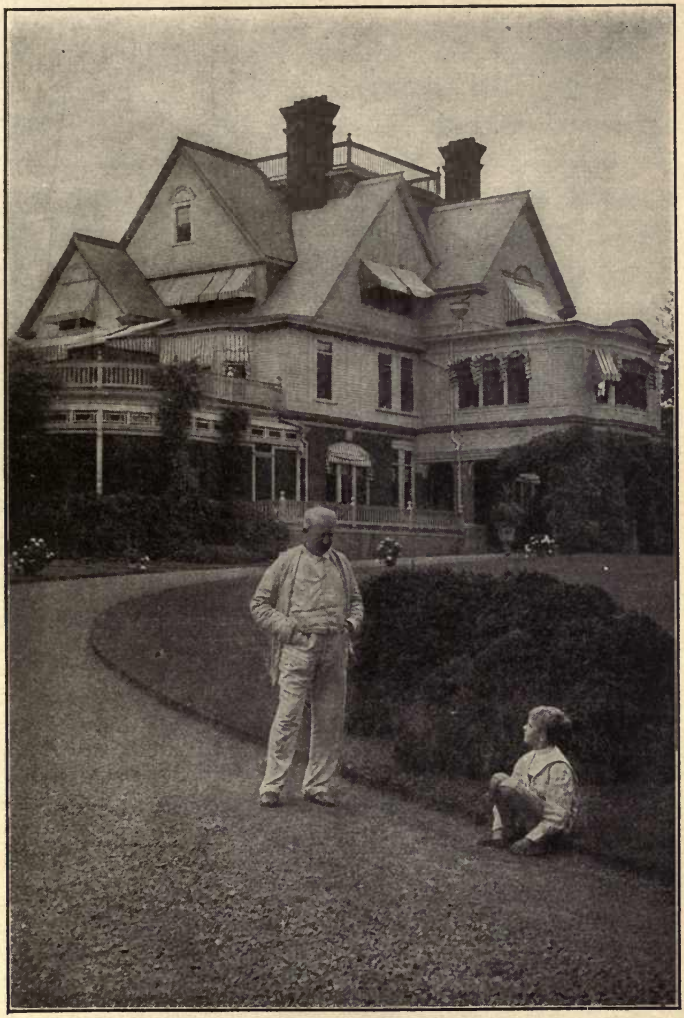
Edison is so busy and so absorbed that he may easily be pardoned such moments of absent-mindedness, from which the whole human race reaps a benefit.

At Orange Edison remains the master-mind of the whole immense organization, although he is still obliged, just as at Menlo Park and throughout his life, to invite the co-operation of the most distinguished specialists. For example, he has entrusted all questions of litigation to Mr F. L. Dyer, an eminent lawyer, learned and far-sighted, whom we have had frequent occasion to quote in these pages. Mr Dyer has no sinecure, for it is he who takes out the patents for Edison's inventions, and their number is known to mount up into the hundreds, both in the

United States and in foreign countries. They range from the quadruplex telegraph to the manufacture of window-glass, from electric locomotion to a method of preserving fruit, from compressed air apparatus to a machine for writing addresses, etc. Not to mention that Mr Dyer's duties involve the continual defence of the inventions, for the infringements of them are innumerable, and consequently so also are the lawsuits. Lastly, some of Edison's engineers, and even some of the assistant workmen, eager to prove their ability and personal ingenuity, make occasional discoveries, which Edison himself is the first to applaud. And patents for these are also taken out by Mr Dyer.

By this time we are moving away from the laboratory, and as we walk along Mr Edison speaks of a recent visit to France, where he was received, just as in 1889, with the utmost enthusiasm. He bestows special praise upon the French automobile roads, French aviation and French cookery.

Before long we arrive at Mr Edison's beautiful residence at Glenmont. In 1886 he was remarried, this time to a Miss Mina Miller, daughter of Louis Miller, a rich manu-



LLEWELYN PARK

Edison prefers his home to all the attractions of the outside world.

facturer and an inventor of agricultural machines; by this devoted wife, brave-hearted, simple in tastes and extremely attached to her home, he has had three children: Charles, Madeleine, and Theodore. This home, situated in the attractive setting of the Orange Mountains, is a delightful one. It is built in English style, of stone and brick, and ornamented with balconies, terraces, and verandahs. It is all very pleasing and in charming taste.

The ground floor comprises a number of parlours and reception-rooms, a dining-room and a large lounging-room, known familiarly as the 'den.' It is here that Edison's various medals and decorations may be seen. In 1889, after his magnificent contribution to the Paris Exposition, costing him personally more than one hundred thousand dollars, Edison was appointed Commander of the Legion of Honour. Other souvenirs of the same period are also preserved in the 'den,' among them a letter from Mme Sadi-Carnot placing the presidential box at the service of Mr and Mrs Edison, the original designs for the invitations issued by the *Figaro* in Edison's honour, etc. There is also quite

a collection of photographs, ornaments, and presents offered to the noted scientist, conspicuous among them being the marble statues sent by the Tsar, vases given by the Japanese Society of Engineers, and a desk set of steel made expressly for Mr Edison at the Krupp Works. And we must not fail to mention the fact that, in addition to all these other objects, the 'den' also contains . . . a phonograph!

Edison retires by preference to the second story. In addition to the bedrooms and a billiard-room, it contains a splendid library, comprising technical works and standard literature, scientific periodicals and popular magazines. Here, when not detained in his laboratory, Edison spends his evenings in the company of his family and intimate friends. He surprises every one by his easy manners, his unaffected humour, his thousand and one inventions and ideas, large and small, always novel, often diverting, yet with a hidden depth of serious import. These evenings are prolonged to a late hour. It no more occurs to Mr Edison that he is in need of rest than it did in the days when he was working at his first telegraph instrument at Port Huron.

His great diversion is to let his pencil run over the surface of a sheet of paper, drawing countless sketches, and absent-mindedly interweaving his signature into all sorts of ornamental designs, and at the same time continuing to talk and argue.

Without having active connexion with any religious sect, Mr Edison is not one of those who deny the existence of God. He does not hesitate to assert that it would be impossible to come into intimate contact with the mysteries of nature, and more particularly to study chemistry, without being convinced of the existence of a supreme intelligence. Yet at the same time Edison has never given himself up to the pursuit of hazy and sterile metaphysics. He remains, in the full acceptation of the word—and this is a point on which it is worth while to dwell—an American genius, of incomparable lucidity, who will not be satisfied with mere words and vague ideas, but insists upon going directly to the facts.

Accordingly, we need not be surprised at his ideas regarding education. They are very clear and uncompromising: "What we need," he says, "is men capable of working. I would not give a penny for young men

armed with college degrees, excepting for those who come from the technical schools." He prefers those who rise from the ranks to those who have been crammed with Latin, philosophy and a mass of other absurdities. And, although his view does not meet the approval of everybody, even in America, he hazards the assertion that "in three or four centuries we shall have reached the epoch of men of letters. At present what we need is engineers, and men of practical ability in manufacturing, commerce, railroading, etc."

All of which, as a matter of fact, does not prevent Edison from having a profound admiration for the arts and artists, especially for musicians. How could a genius such as his fail to sympathize with a Beethoven, whose gigantic art is also made up of constant and manifold combinations and inventions, in pursuit of dreams and ideals? And this is why Edison is passionately fond of the *Symphonies*.

Among the most agreeable memories of his sojourn in Paris in 1889, Edison recalls not only his interviews with scientists such as Pasteur and Jansen, his visits to the galleries of the Louvre and the Luxembourg, the

latter of which he preferred, but also a musical *séance* which Gounod offered to give for him and Mrs Edison alone at the top of the Eiffel Tower.

Do not let us exaggerate the importance of details which, without amounting to a profession of faith, bear witness to the need felt by this remarkable self-made man for a certain element of the empirical and utilitarian.

In any case, if rightfully or wrongfully we are partisans of the old classic training and resent Edison's partiality for the hard discipline of life and experience, we cannot help surrendering ourselves more and more to the charm of the man himself in private life. This famous wizard wears quite the same clothes as any one else, without a touch of dandyism, and with a secret preference for his everyday, much-worn working clothes. He is fond of good living and a varied menu, but decidedly prefers fruit to meat. Far from disdaining a variety of courses, he is the exponent of an original theory that the great nations are the nations which partake of the greatest variety of dishes. In support of this assertion, he delights in making a

comparative examination of the different races. "The nations which eat rice," he says, "never make any progress. They never make anything excepting rice, rice, always rice!" We may observe in this connexion that China seems to be awakening from her lethargy of centuries. Does this mean that, after discarding their queues, the Chinese will cease to be eaters of rice? We should note also that Mr Edison's opinion regarding French cookery is an extremely flattering tribute to the intelligence of the race.

Mr Edison, however, is far from being an over-indulgent eater, or even a gourmand such as Balzac or the elder Dumas. He avoids alcohol, but he does not recoil from a cup of coffee or a good cigar. He has no time to waste upon sports nor even upon exercise. Yet his health suffers in no way from this lack. In short, he lives a most secluded and peaceful life at Glenmont, in spite of the occasional inevitable visitors who must be received. This eminently family life is enlivened by the coming and going of Mr Edison's children and by the annual winter trip to Fort Myers, Florida,

where he has an attractive house, a garden of luxurious vegetation, and a laboratory. He spends a few weeks there each year, without interruption to his labours, for this laboratory, although less complete than the one at Orange, contains all the equipment necessary to enable him to carry on his personal experiments.

Supposing now, at the risk of committing an indiscretion, but urged on by a profound desire to solve the marvellous secret of this superman, that we should venture to question him as to his methods of work and research.

Mr Edison would begin by replying that it is usually a mistake to attribute inventions to accident or chance. But rather serious blunders have been made in regard to this very point. A few of his inventions, to be sure, may have been the result of a lucky find, but the great majority have been born of enormous and patient labour, and are due to an innumerable series of experiments all directed toward a well-defined goal. Hence arises a distinction which this scientist, this experimenter loves to make, and which causes us a certain mild regret, because we have employed successively the two words in

question without stopping to differentiate them.

"A discovery," says he, "is not an invention. For my own part, I hate this confusion of meaning. A discovery is something which happens more or less accidentally. A man is following a certain road. He is going, for instance, from his home to the railway station, intending to take a train. All of a sudden his foot strikes against some object. He stops, bends down and searches. He finds a gold bracelet, buried in the dust. Well, he has made a discovery, but he certainly has not made an invention. He has gone to no trouble to find this bracelet; and yet its value to him is precisely as though after long years of study he had invented a machine for the manufacture of gold bracelets."

Edison's favourite definition of a discovery as a 'nail-scratch' belongs to precisely the same order of ideas and metaphors. An invention, on the contrary, is the fruit of assiduous care, of long and methodical effort, and God knows that it is never a fruit easy to gather and that it frequently remains green, or else, at last, ripens in spite of its inclement

surroundings, thanks to the knowledge and unwearied vigilance of the attentive gardener.

What is the secret of his genius? That is the question which we still ask ourselves after leaving Mr Edison — after having studied his life and his works, to the end of determining those principal features of his physiognomy which belong to humanity as a whole.

Yes, what is the why and the wherefore of his glory, of his colossal success, the mark of which is borne to some extent by the whole universe? We have not failed to insist, in passing, upon the dominant character of this powerful and intense personality, which incarnates the American spirit in its greatest freedom and fertility, its most positive and audacious aspect.

In order to guard against any mistake, in attempting to solve this problem, and to arrive at a reasonable conclusion, it is wisest to appeal to those fellow-countrymen of Edison's who have enjoyed a prolonged and close intimacy with him throughout the chief periods of struggle and of victory—namely, Mr Frank Lewis Dyer and Mr Thomas Commerford Martin—whose close observation

nothing pertaining to Mr Edison seems to have escaped—excepting, no doubt, such details as escaped Mr Edison himself and such as no one on earth could have been expected to catch.

Edison, they say, combines with a physically robust constitution a mind capable of clear and logical thinking and an imagination of unusual activity. But this would by no means offer a complete explanation. There are many men of equal bodily and mental vigour who have not achieved a tithe of his accomplishment. What other factors are there to be taken into consideration to explain this phenomenon?

First a stolid, almost phlegmatic nervous system, which takes absolutely no notice of *ennui*—"a system like that of a Chinese ivory carver who works day after day and month after month on a piece of material no larger than your hand." Here is one example out of a thousand. In order to complete one of his batteries, he spent five years in experimenting with nickel tubes, and these experiments, always apparently the same, cost him more than a million dollars. To any one else this research would have become

odious after the lapse of a few hours. But, at the end of these five years, Edison still showed just as much enthusiasm as though this problem of completing his battery with a single insignificant detail had just been brought freshly before him.

But on other occasions Edison has shown in a thousand ways the fertility of his resources. And how many times he has had occasion to take a hand in enterprises that have been given up as hopeless by his assistants! On one occasion he had need of a new machine to perform a specified kind of work. He turned the matter over to his engineers and gave them the necessary specifications. After a certain lapse of time they brought him three plans for machines that in their opinion would be capable of performing the required work. Edison examined them and found that none would answer. "Do you mean to say," he asked, "that these drawings represent the only way to do this work?"

"We are sure," replied the assistants in chorus. No one can be expected to do the impossible. But Edison insisted:

"You are absolutely sure?"

"Absolutely," came the simple and unanimous reply.

This happened on a Saturday. The following Monday, when Edison came to the office, he handed his assistants, without comment, forty-eight plans for machines based upon analogous principles. What was the use of comments? He relied upon results, always results, nothing but results.

Here, parenthetically, we may lay our finger, in a measure, upon the essence of genius. It is all in vain that Edison modestly disputes it and talks of a great aptitude for toil and research. It is quite useless for him to compute invention as composed of 1 per cent. inspiration and 99 per cent. perspiration, to quote his humorous and yet significant definition. The exceptional element does not consist in mere labour, even compulsory labour, prolonged to the limit of human endurance, but in inventive labour, if one may be permitted to use this new term.

Edison makes discoveries where others, endowed with keen intelligence and a rare measure of energy, discover nothing. Furthermore, let us note that this faculty is employed

quite as often for trifling matters as it is for those that are of far greater importance. He is convinced that in the whole realm of invention insignificant details are frequently of infinite importance. This is the reason of his innumerable laboratory notes, in which he follows, day by day, the progress of an experiment conducted with the aid of the greatest variety of elements—and it must not be forgotten that Edison spends reckless sums of money in order to succeed in producing a maximum result through the simplest and most economical means.

Let us pass on to the second factor: a positive, complete, and invincible optimism, fortified by forty or fifty years of experience, an optimism which has never been shaken by any set-backs, independent of his science and his will. Far from fearing toil and difficulties, he delights in them. Fighting a feeble enemy, conquered in advance, is not fighting at all!

Let us take still another characteristic trait. Edison consecrated more than five years of superhuman activity to the exploitation of his electro-magnetic separator for iron ore, and the commercial enterprise ended in

disaster. At the age of fifty he had lost a fortune. Nevertheless he left the scene of his defeat calm and light of heart, satisfied in having proved the success of an invention, even though he had made a business failure. And later, when he revisited the site of his lengthy struggles, he declared serenely: "I never felt better in my life than during the five years I worked here. Hard work, nothing to divert my thoughts, clear air and simple food made my life very pleasant. We learned a great deal. It will be of benefit to some one some time."

We realize, upon reflection, how disinterested and stoical his conduct has been, how it has placed all his business relations upon a higher plane, and how it is the natural outcome of an uncommon strength of will, coupled with the inborn forces of his temperament and his race.

From childhood up it seems as though Edison had flung a glance of defiance at all obstacles which barred his path or that of others, including the whole human race. Consequently he acted without vain declamation or idle posing, but with the implacable resolve to triumph, thanks to a higher

understanding of the means at our disposal, whether through sudden and salutary action or through slow, detailed, and progressive observation.

Whether it is a question of making a newspaper or a telegraph instrument out of nothing, of sending a dispatch without the aid of instruments, of forcing sound to transmit itself and be preserved intact, of forcing light to become concentrated in a given lamp during a specified time and with a specified brilliance, Edison is the man who succeeds in eliminating hindrances and solving the enigma.

And this is how Edison appears to us in final analysis. The seeker, the inventor has achieved his object in full measure, because his immense knowledge and his prodigious skill as a practical mechanic, who refuses to be rated as a scientist, hampered by theories, but works steadily toward a definite goal with dogged determination, have been inspired by the unquenchable and joyous energy of a hero.

Thomas Alva Edison, the King of Electricity, the physicist, the chemist, the American manufacturer, the modern enchanter, the

master of creative thought, who has the gift of subjugating the most mysterious forces of nature and placing them at our service, remains for us, as for posterity, first and foremost a great conqueror.

FOURTEEN DAY USE
RETURN TO DESK FROM WHICH BORROWED

This book is due on the last date stamped below, or on the date to which renewed.
Renewed books are subject to immediate recall.

18Nov'55BH

NOV 7 1955 LU

16Jul'60MM

REC'D LD
JUL 2 1960

120ct'60BM

REC'D LD
SEP 28 1960

JAN 30 1970 50

REC'D LD JAN 16 '70-3 PM

NOV 16 1984

RECEIVED BY
NOV 13 1984
CIRCULATION DEPT.

LD 21–100m-2,'55
(B139s22)476

General Library
University of California
Berkeley

YB 75223